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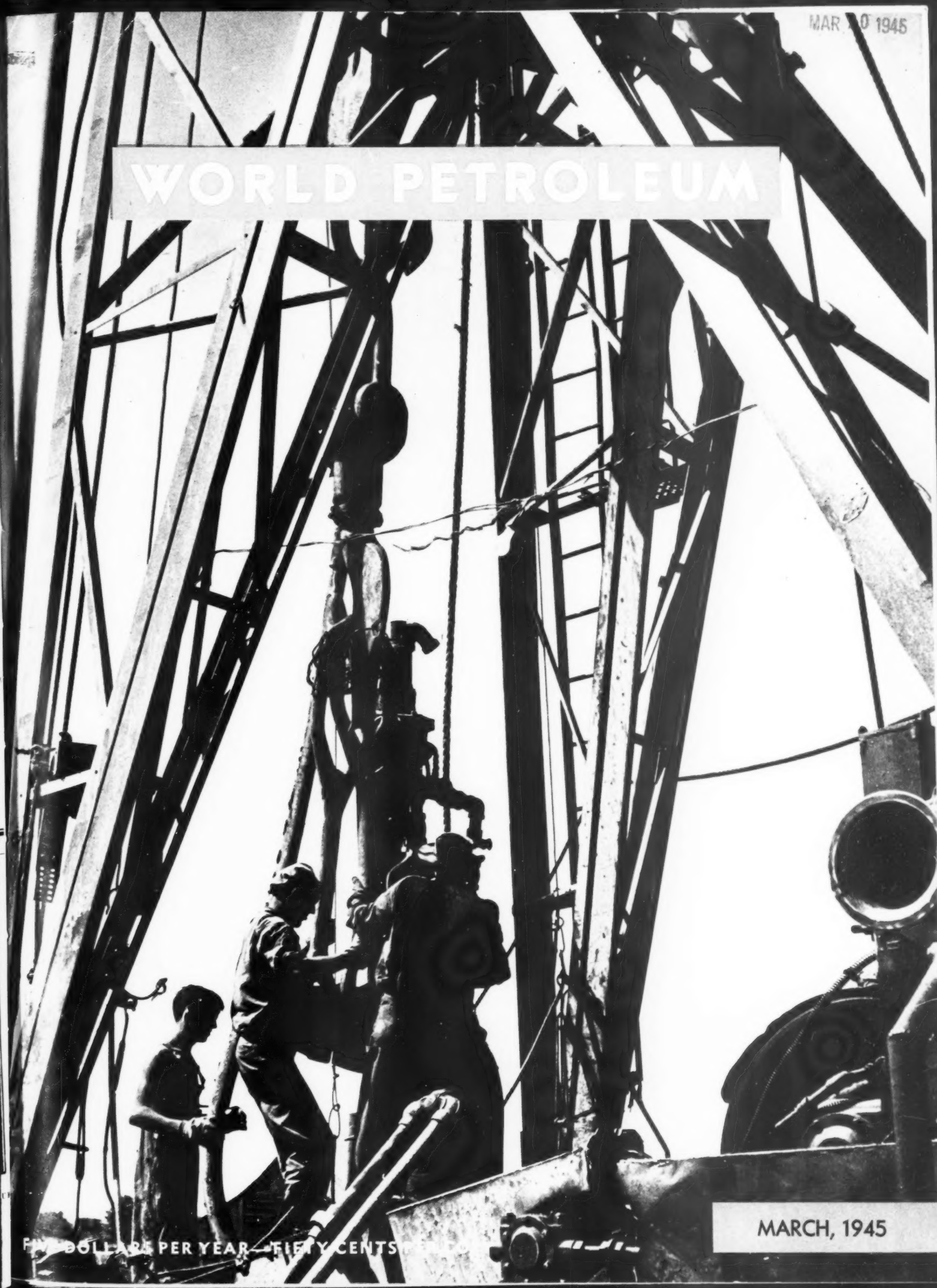
WORLD PETROLEUM



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WORLD PETROLEUM

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CONTENTS

Oil Industry's Critical Year 35
Previous Records Surpassed in 1944 . . 36
Diesel Engines for Oil Field Drilling . . 40
New High in World Production 43
More Drilling Rigs — Slower Operation 44
Increased Geophysical Prospecting . . 46
New Moves in Secondary Recovery . . 50
Filtrol Fractionation 54
California Standard's New Unit . . . 56
Britain's 1000-Mile Pipe Line 58
Sun's New Research Laboratory . . . 60
Washington Notes 62
Oil Company Staff Changes 64
Petroleum Abstracts 92

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Richard D. La Fond
Advertising Manager

Sofie Cihowski
Assistant Editor

H. Arnold Jacobsen
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Drilling in Michigan.

EDITORIAL

OIL INDUSTRY'S CRITICAL YEAR

BECAUSE the oil industry has met all of the exacting demands placed upon it by the necessities of war and in practically all instances has kept well in advance of the schedules set for it, the true extent of the effort involved has attracted less attention than it has deserved. The flight of bombers over hostile territory, the drive of tanks against enemy lines or the advance of a fleet in battle formation, is far more spectacular than the drilling of holes in the earth or the construction of complicated plants to convert the liquids so obtained into the specialized forms of fuel that make possible the movement of these mighty weapons of destruction. Without the petroleum products expertly fashioned to impart deadly efficiency to such mechanical instruments they would be absolutely useless. This war is being won through the concentrated efforts of millions of men working in hundreds of separate lines of endeavor but oil is the catalyst that blends all their efforts into a successful outcome.

In the past four years the American oil industry has performed stupendous physical tasks any one of which might well have been hailed as an industrial miracle. It has added nearly a million barrels a day to an output that already was at the highest point in its history up to that time. It has provided the processes and facilities that have multiplied more than fifteenfold the production of aviation gasoline and has given to the United Nations unchallenged domination of the skies. It has been instrumental in establishing a vast new industry that is turning out by synthetic processes more rubber than ever was consumed when dependence rested solely upon the natural product. It has created a transportation system without which it would have been impossible to move essential petroleum products to the front with the speed and in the volume needed. It has done all this and much more in the face of materials and manpower shortages that made its attainment appear well nigh impossible when the tasks were begun.

It was believed, and this assumption was shared in official circles, that the heaviest part of the job would be completed by the end of 1944. The huge program for the construction of plants designed especially to turn out high octane gasoline, toluene and other specialized war products was nearly completed. The synthetic rubber output was moving in high gear and promised to yield supplies adequate for full needs. The transportation system was functioning smoothly and the emergency pipe lines were handling traffic beyond their rated capacity. It was believed that military requirements had reached an approximate peak, that demands from the European theatre would shortly be eased and that product supplies thereby released would be sufficient to take care of increasing needs in the Pacific. The industry did not relax its efforts in any respect but it was led to look forward to a period when its burdens would have ceased to grow and when it could adjust itself to carrying this maximum load as long as might prove necessary.

Instead of this reassurance the sharp revision of military plans based upon indications of a prolonged struggle in Europe and a swift expansion of operations against Japan has faced the oil industry with new and exacting demands. These fresh requirements promise to verify the forecast made in these pages sometime ago that 1945 would prove the most critical year of the war so far as oil was concerned. It is critical because the extra load is being added to a burden that was generally held to mark almost the limit of oil industry performance under existing conditions. It is complicated by the simultaneous decision of the military authorities to add nearly a million men to the armed forces and to step up the output of certain types of munitions which consume the same materials that must be used in drilling and in war plant construction.

Some means of circumventing a major part of these difficulties will be found. New men are being trained to take the place of those who have left the ranks. The rival claims of armament production and of the industrial effort needed to make the use of that armament effective will be adjusted on some reasonably equitable basis. Otherwise, as Materials Director Parsons of the Petroleum Administration has so aptly phrased it, "the military will find themselves in the tragic position of having mechanized units that have no fuel or lubricants to operate them."

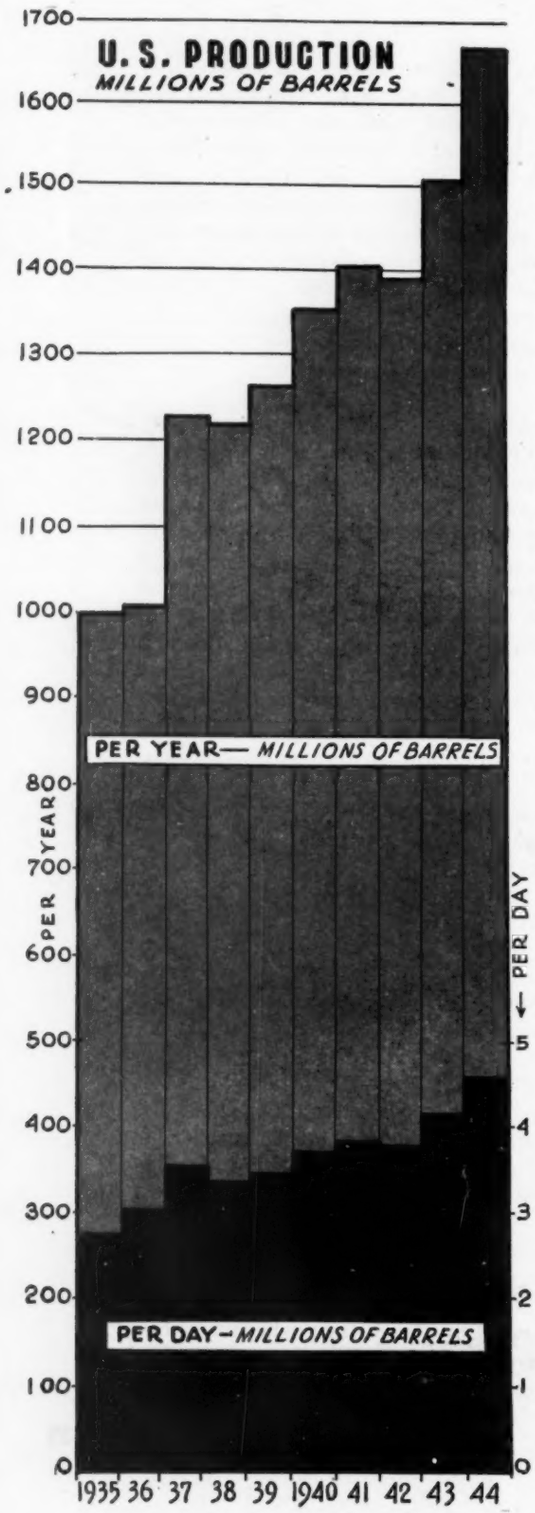
The oil industry has not failed the nation at any point in this war emergency and it will not fail now, no matter how great sacrifices may be involved. It will be instructive to note in the future whether these sacrifices are remembered and taken into account in the treatment accorded the industry.

U. S. OIL INDUSTRY SURPASSED ALL PREVIOUS RECORDS IN 1944

Gains of 11.5 Percent in Production, 22 Percent in Gasoline Output, 26 Percent More Wells Drilled, Reflect Rising Tempo of Activity in Meeting War Demands — PAW Calls for Still Greater Effort to Satisfy Rising Requirements of Current Year.

AGAIN in 1944, as in the previous year, the oil industry came through with a new high record of accomplishment in the domestic production of crude. The preliminary figure of output is 1,678,500,000 barrels, topping the previous peak of 1,505,613,000 attained in 1943. The daily average rate was about 4,600,000 barrels, nearly 500,000 more than the 4,125,000 average for the preceding twelve months, and far above the 3,327,000 daily average for the pre-war year 1938.

A steady rise in production during the first half of 1944 brought the total crude output in July to a point above the maximum efficient rate. The increase continued till a peak production of 4,766,000 barrels a day was attained during the month of September, when the output began to ease off and continued at a slightly lower rate through the final quarter.



The largest contribution to the rise in production during 1944 was made by Texas with an increase of 156,000,000 bbl. or roundly 25 percent. Texas, in fact, supplied 44 percent of the nation's crude output. Next in line was California with a rise of 27,000,000 bbl. Eleven states showed a gain in production while nine states fell behind their 1943 record, most of them by relatively small amounts.

In its effort to replace its depleting reserves due to the heavy drain, industry set a new high during 1944 in the number of wildcats drilled—over 3,800 in the United States, a sizeable increase over the 3,512 drilled in 1943 and 3,223 in the previous year. Although the number of exploratory wells fell short of the number programmed for the year, industry topped the 24,000-well goal for all drilling set by the Petroleum Administration for War. This was a big advance over the 19,000 wells completed annually in the two previous war years.

While the number of well completions in the country reached a total of 24,150 according to preliminary calculations, this includes some input and disposal wells not sunk primarily for the production of oil. Of the remainder the number brought in as oil producers was 13,205 or slightly over 60 percent while 2,360 were productive of gas or distillate and the remaining 7,504 were dry holes. Principal discoveries during the first six months of 1944 were made in Texas, southern Louisiana, and southern Mississippi. Alabama for the first time entered the ranks of oil producing states.

This fine showing was made in spite of the dislocation in manpower and continuing shortages of some important materials and equipment, situations which are expected to become even tighter during 1945.

Discoveries in 1944 exceeded by perhaps 500,000,000 bbl. those made during 1943 of approximately three quarters of a billion barrels of crude. These additions to reserve were not sufficient to offset the 1944 production of nearly 1,700,000,000 barrels leading to a small reduction in the total volume of known reserves.

One of the most significant developments in oil exploration during 1944 was the extension of Ellenburger production in West Texas and into New Mexico. According to Deputy Petroleum Administrator Ralph K. Davies, the productive potentialities of this area cannot be fully estimated without further exploratory and development work. Discoveries of oil and extensions of fields in Mississippi open up an important oil producing area east of the Mississippi River. Intensive exploration activity is being continued in this area but as yet the extent of the reserves cannot be estimated reliably.

The 1944 production of natural gasoline and products from cycling plants is estimated at 101,000,000 barrels, or an average of 274,000 barrels daily. This is an increase of 57 percent over the daily average production of 175,000 barrels of natural gasoline and allied products in 1941. The increase in the output of these products is of special significance at this time because of their importance in the manufacture of high octane aviation gasoline..

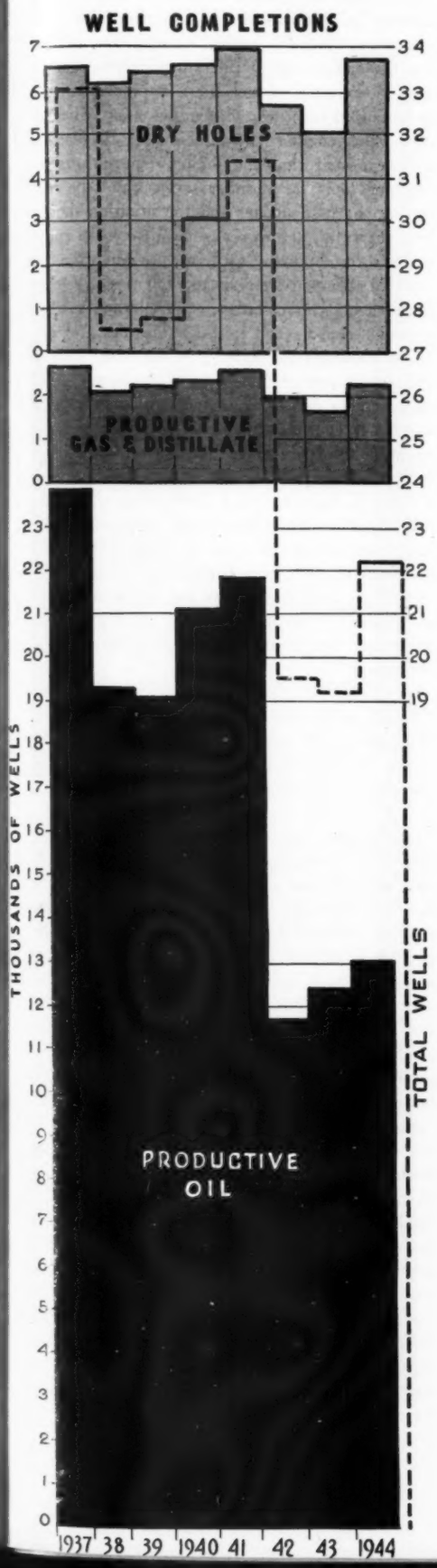
Runs to stills increased during 1944 at a higher rate than crude production (15.7 percent against 11.5) resulting in a further reduction of crude stocks. The output of all principal oil products was larger than in 1943 but the emphasis was on gasoline including aviation fuel, the production of which increased 22 percent as compared with a rise of 11 percent for all other products, a reflection of the rise in military requirements as there was no substantial change in civilian consumption.

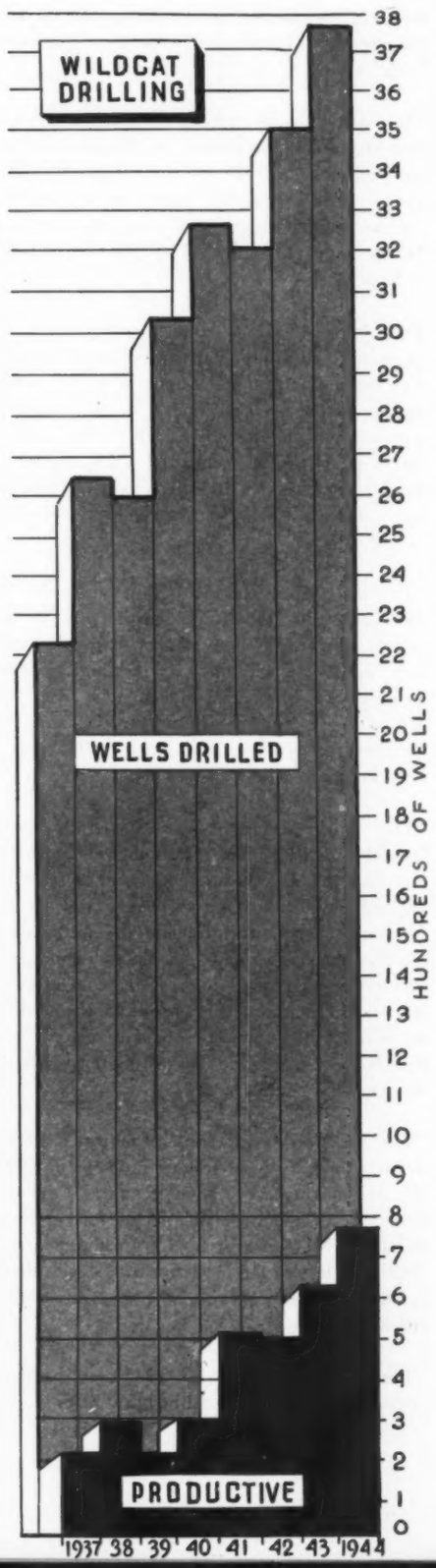
Now that the optimism of last summer over the prospect of an early collapse of Germany has vanished, Washington officials are planning grimly on further increases in production through 1945 and into 1946. Talk of early conversion of plants to civilian production has been dropped, and the search is on for materials and manpower to keep war production at the present high level, and even higher in some essential products.

To meet the present wartime demands for petroleum products on all battlefronts and at home, the production of crude in the United States

must continue at the high rate of approximately 4,700,000 barrels a day throughout 1945, according to the goals set by PAW. This is regardless of whether and when the European theater is liquidated, for when that happens the forces consuming petroleum products will be shifted to the Pacific theater. The major burden of supplying war products will continue to fall on the domestic industry and its reserves.

To maintain the 4,700,000-barrel daily output, PAW says it will be necessary to drill 27,000 new wells in 1945, or 3,000 more than were drilled last year. Of these 5,000 should be wildcats, the same requirement asked for by the Petroleum Administration in 1944. It is estimated that the new drilling program will call for approximately 2,014,000 tons of carbon and alloy steel or about 16 percent more than estimated requirements for this type of operation during 1944.





In addition, the petrolem industry will spend, according to Deputy Administrator Davies, about $52,000,000 in each quarter of 1945 for the domestic construction of refinery units and for natural gasoline and cycling plants. This construction program on the basis of carbon steel calls for approximately 20 percent more materials than the 164,000 tons used during 1944.

Miscellaneous operations during 1945, including the construction and maintainance of transportation and marketing facilities, will call for about 174,000 tons of steel. About 170,000 tons was used in this type of operations during 1944. PAW's schedule of operations for the petroleum industry for 1945, officials stress, constitute the minimum program necessary to meet military and supporting civilian requirements for petroleum products. Davies makes the promise that "even though the materials situation is becoming tighter, every effort will be made to obtain the materials, equipment, and supplies necessary to carry out this minimum program."

In a report to the Petroleum Industry War Council at its January meeting, Claude P. Parsons, Director of Materials of PAW, sounded a pessimistic note on the outlook for 1945. In part, he told the Council:

"Contrary to the optimistic expectations of a few weeks ago, the military uncertainties and setbacks in Europe at the end of 1944 and the acceleration of the war in the Pacific have caused a drastic change in the materials situation as we enter 1945. In general, as long as the present military uncertainties continue in the new year it will be more difficult to obtain materials for petroleum operations than in any previous period of the war.

"More specifically, the main factors which are affecting petroleum operations are (1) increased military demands for equipment and manufacturing facilities which are also needed for petroleum operations, (2) increased petroleum production programs, foreign and domestic, and (3) effects of manpower shortages of basic manufacturing facilities.

"The increased military demands which especially affect materials for petroleum operations are the rocket, bomb and shell programs, which are in conflict with the production of oil country tubular goods, tool joints, rock bits and other items. Increased military demands for other critical supplies, including heavy trucks, heavy tires and tractors, also affect the materials outlook for petroleum operations.

"Manpower shortages in basic manufacturing facilities affect many critical items, almost clear across the board. Shortages of basic components, castings and forgings are causing shortages in finished petroleum equipment.

"A great many refinery projects were completed in 1944 to produce the greatly increased amount of 100-octane gasoline, motor fuels, lubricants, ingredients for synthetic rubber and toluene for TNT, needed for the war. While additional projects will still be required during 1945, attention must be given to supplying the greatly increased demand for crude petroleum to keep the refineries operating. This means that exploration, drilling, production, pipe lines and other means of transportation, natural gas and gasoline, must be coordinated with the demand for finished petroleum products.

"The domestic petroleum production program for 1945 calls for the drilling of 27,000 wells as compared with 24,000 in 1944. At the beginning of 1945 there are 1800 rotary rigs in operation in the United States, as compared with 1300 at the beginning of 1944. From a materials viewpoint, in view of the present outlook as described above, this increased drilling program may run into countless difficulties.

"Oil country tubular goods, especially, may become a serious problem beginning in the second quarter. The conflict has actually begun in the first quarter but will not be serious. On the basis that the war in Europe will continue through 1945 and into 1946 the serious situation which will begin in the second quarter will continue in subsequent quarters unless some means are quickly found to prevent the expected shortage.

"This condition was brought about by a recently stepped-up military program for rockets, bombs, and shells. The conflict is due to the same manufacturing facilities being used to produce the steel cases for rockets, bombs and shells that produce oil country tubular goods vitally needed to meet the demands of the war for ptroleum and petroleum products.

"While final figures are not available yet, a measure of the possible extent of the conflict is shown in the following tentative figures for the second quarter for seamless and electric weld tubular goods:

	Tons
Military requirements	329,200
Petroleum requirements foreign and domestic	332,000
Total requirements	661,200
Total capacity of mills	516,000
Shortage	145,200

"Every effort is being made to resolve this conflict and, if possible, to eliminate the shortage, but if in the end additional facilities cannot be obtained in time to produce the greatly expanded military demand and if the impact must fall upon the petroleum program, it will mean that there will be tubular goods available for only 3400 wells in the second quarter as compared with a drilling program of 6900. The seriousness of this situation is fully realized and the matter will be carried to the authorities who are in best position to appraise the conflict and to make decisions between petroleum and other war items, or to decide whether new manufacturing facilities can be provided. It is hoped that this conflict can be avoided.

"On January 3, 1945 we released a letter to all manufacturers of petroleum equipment, petroleum operators, suppliers and distributors, for the purpose of properly aligning the use of ratings for acquiring repair parts and replacement items to keep existing rigs in operation, as compared with the starting of new rigs. This matter had gotten out of balance and many operators had complained of not being able to keep existing rigs in operation while new rigs were being started.

"The deliveries of internal combustion engines from manufacturers showed an improvement and the outlook for 1945 is more favorable than 1944. The November deliveries of drilling engines (over 500 cubic inches displacement) was 245 as compared with 232 in October and 179 in September.

Tool joint deliveries from manufacturers are increasing and production is expected to increase progressively through March of 1945 when the last of the new machinery for the expansion program will be installed. December production was 34,529 as compared with 25,107 in April. The backlog of orders is still tremendous and will remain so through a considerable part of 1945.

"The drill pipe situation will be improved by the increase of tool joints but it may be adversely affected by the conflict with the military in the pipe mills, as explained above. Tractors of the track-laying type are still critical due to tremendous military demands but we have received an allocation for 1945 that is a slight improvement over 1944.

"The truck situation looks generally more favorable in 1945 than it was in 1944 with the exception that new heavy trucks will be seriously affected by the shortage of heavy tires. In discussions of the tire problem we were asked whether emphasis should be placed upon heavy tires for new trucks or for replacements on existing trucks. In accordance with established policy, we advised that emphasis should be placed upon both but as a last resort the existing trucks should be given first consideration.

"The heavy tire situation, as indicated above, will continue to be a serious problem in 1945. We are making every possible effort to get our due share of the tires and petroleum continues to have a No. 1 priority. As a great deal of the decision is left to the local tire panels, petroleum operators should continue to press their claims and appeals.

"The lumber situation for 1945 will be more critical than in 1944. Although Order L-335 has been effective in channeling available lumber to the most essential industries, the total available amount has been adversely influenced by the shortages of manpower and materials. From present indications petroleum operations will receive approximately 15 percent less lumber in the first quarter.

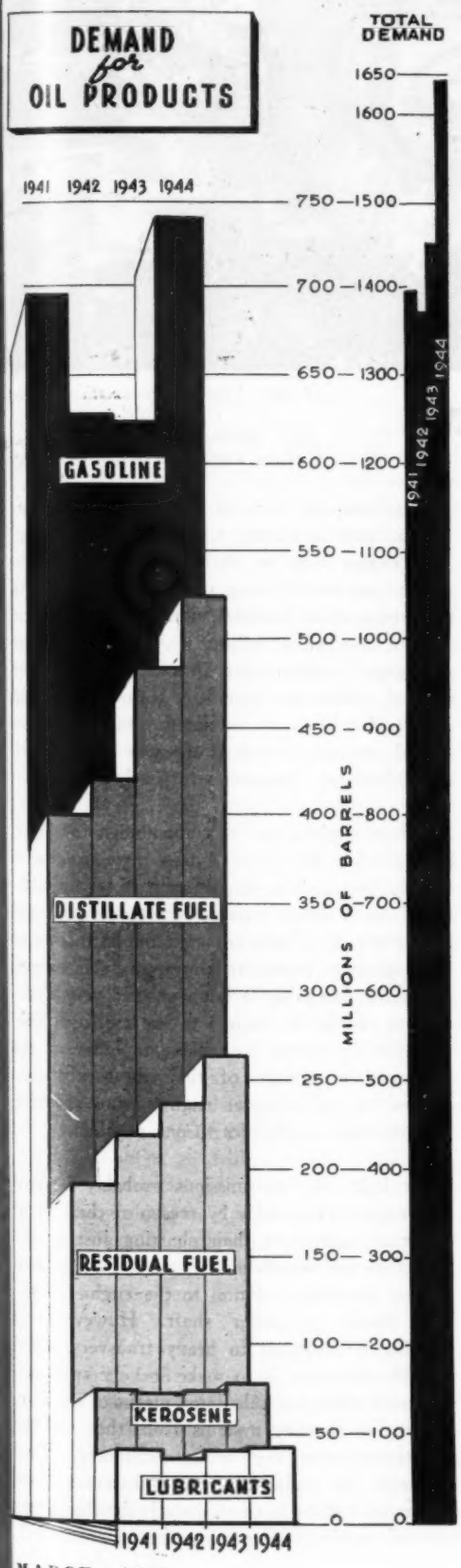
"Petroleum equipment manufacturers are being assisted by our expediters in getting additional machinery and the critical components needed for the completion of their manufactured products. Some types of machinery are more difficult to obtain than others, depending upon whether or not they conflict with the military. In general, it is expected that the major requirements of machine tools for military services will be met during the first quarter and the situation should ease thereafter. However, some items, like radio drills, are obtainable at the present time on unrated orders at from six to eight weeks. Other items such as turret lathes, engine lathes, surface grinders, shapers and milling machines are now being scheduled for delivery in the latter part of the second quarter. The surplus machinery situation changes day by day. As machinery becomes surplus it is listed and many manufacturers of various industries have representatives, either individually or through one of the agencies like PAW, on hand to check these items daily and take steps to obtain those that are needed. We have men doing this type of work and manufacturers of petroleum equipment should advise us of their needs so that we can maintain a constant watch therefor. We have already assisted numerous manufacturers in obtaining surplus machinery.

"Aluminum became easier in 1944 but aluminum sheet, strip and shapes have become very critical again, not due to lack of raw materials but from shortages in manufacturing facilities.

"Due to the recent military situation in Europe, the War Production Board has adopted a realistic attitude that as long as the present military uncertainties exist, construction of new facilities will be authorized only in compliance with the provisions of the directives for war-time construction, and those in the Board who are concerned with construction have been instructed not to deviate from the provisions of this directive. During the latter part of 1944 it was possible for PAW to process projects which were border-line cases but this new tightening indicates that such cases may be denied. However, we do not expect undue difficulty in having projects approved for the removal of bottlenecks in major projects covering the construction of facilities for the manufacture of ingredients and blending agents for 100-octane gasoline, when such agents and ingredients are necessary to maintain the presently authorized output of 100-octane gasoline. We also do not expect undue difficulty in obtaining the approval of projects for pipe lines where additional capacity is needed to handle the output of oil fields which do not now have adequate facilities, and for pipe lines to

serve newly discovered fields. It is doubtful, however, if projects will be approved which cover refinements of operations, conveniences, expansions, and other types of projects which can be delayed without reducing the output of petroleum products essential in the war program.

"Lead has become very critical due to the shortage of manpower for mining and smelting



The situation has become so acute that lead was placed on allocation and Order M-38 provides a list of restricted uses. This shortage may affect the petroleum industry directly in the use of tetra-ethyl lead for gasoline and indirectly in the reduced amount of lead for the manufacture of storage batteries, lead pipe, fittings and sheet lead. The shortage of lead for tetra-ethyl lead is being given serious consideration by all concerned and every effort is being made to obtain sufficient amounts to maintain the present qualities of motor fuels for essential civilian use. This is one of the very serious problems with which we are confronted at the present time.

"Copper tubes may become more critical in the first and second quarters, due to increased military demands and diversion of labor in the mills to the larger sized tubes. Difficulties may be encountered in obtaining sufficient sheet, strip, tubing and wire.

"Boilers are becoming more critical due to the structural shapes, plates and tubes becoming more difficult to obtain. Fabrication after receipt of material does not present a problem at the present time, nor do boiler accessories. Turbines have not become more critical but there are indications of a stepped-up maritime program which may seriously affect this item. Motors still remain a very difficult item, with practically all production going to the heavy artillery and landing craft programs. Motor controls are likewise a problem. All orders for electrical equipment should be placed at the earliest possible date to provide for as long as a manufacturing lead time as possible.

"Pumps do not present any particular difficulty directly but a long lead time is required for motors needed for electrically driven pumps. Therefore, if early delivery is essential, consideration should be given to other types of drive, such as the steam turbine.

"Almost all types of conventional valves and fittings have been relatively easy to procure for the past six months, provided that the normal procurement figure of between 60 and 90 days was allowed. The present lead time now stands at between two and four months and it is expected that this may ease somewhat further. However, the present trend of manpower shortages may have an effect on the availability some time during the first half of 1945. Additional factors which may affect the situation are recent increases in requirements for the military and maritime. Specific valves which in the past have been difficult to procure and for which future requirements may become increasingly difficult are as follows: Motor operated valves, present lead time approximately six months for the motor-drive; plug valves of all types, three to five months; alloy coated valves for Hydrofluoric Acid alkylation plants, three to five months; alloy valves for Isomerization plants, three to five months.

"Steel plate, heads and heat exchangers are favorable but pressure vessels are presenting somewhat of a scheduling problem in certain plants.

"The present lead time on structural steel members is 120 to 150 days on regularly placed orders. Steel sheet continues to be the tightest of these items, current orders now being promised September and October deliveries.

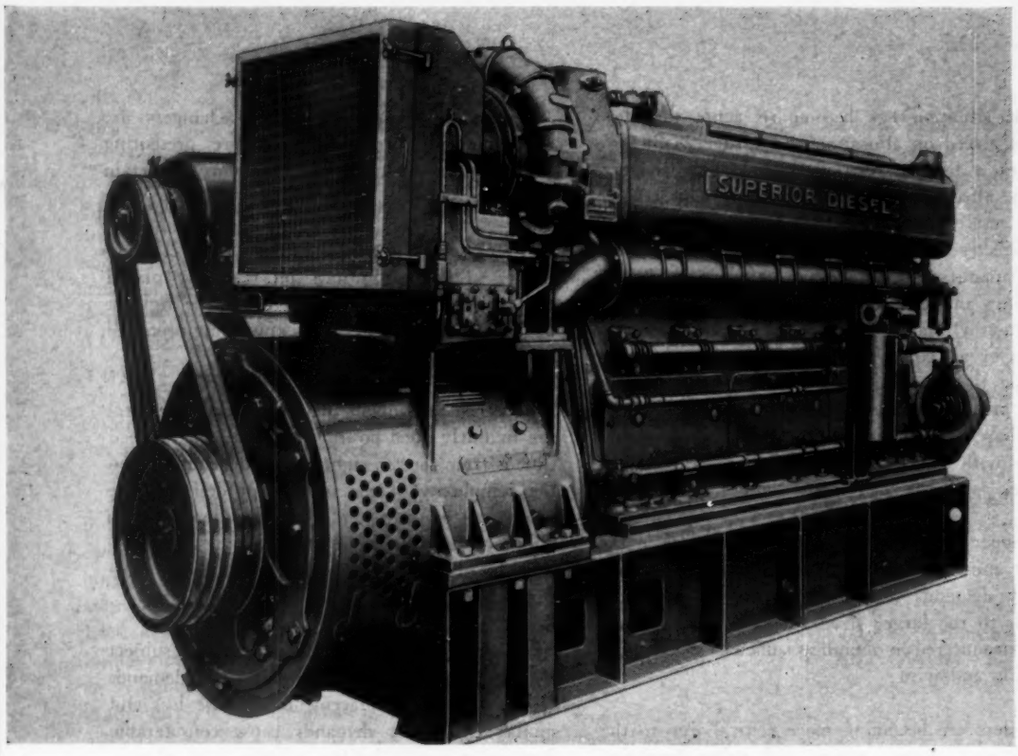
"Industrial instrument manufacturers in general are in fairly good position and the general lead time is from four to eight weeks, depending upon the complexity of the instrument desired. One manufacturer, however, is heavily loaded with military orders with very high ratings and considerable difficulty is encountered in getting orders schedule for early delivery.

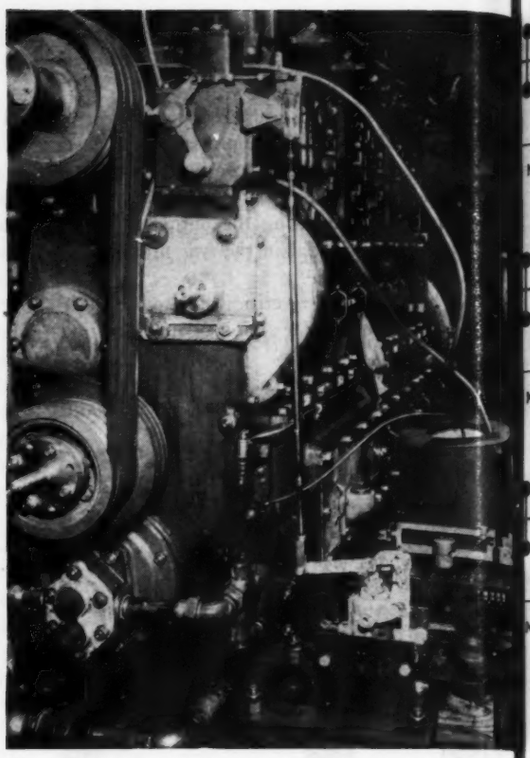
"The situation in the electronics field is subject to considerable variation due to the demands of the military. Replacement of battle loss and similar emergency demands cause considerable fluctuation in availability of this type of material. At this time electronic components such as tubes, condensers and resistors, can be obtained without too much difficulty. However, assembled equipment such as radio receiving and transmitting equipment, electronic test equipment and transformers are very tight.

"The manpower trend is still seriously hurting the basic industries which provide castings and forgings for many items used in the various branches of the petroleum industry. Certain components, especially bearings and gears continue to be very critical.

"If military demands for trucks, tanks, airplanes, and ships increases, it is obvious that there will be an accompanying increase in demand for petroleum products to keep these mechanized units in operation. This in turn makes it necessary for petroleum operators to obtain sufficient materials and to meet their increased obligation to provide more petroleum products for the war. Therefore, the problem must be resolved by the responsible agencies. One thing is certain, if the industry does not receive enough materials to meet anticipated increases in military demands for petroleum products, the military will find themselves in the tragic position of having mechanized units that have no fuel and lubricants to operate them.

"Petroleum not only serves as the power for combat units in the air, on land and sea; it is also a potent factor in synthetic rubber for tires, in TNT explosives used in ammunition, and in a long list of various and sundry items, including medicines. The tonnage of petroleum products shipped from our shores to combat areas continues to be greater than the tonnage of all other supplies combined. This vitally important item of combat simply must not fail for lack of materials needed by petroleum operators to fulfill their tremendous responsibility."





Above: Test of Pneumatic Control on Diesel.

Left: National Superior Diesel and Driving Variable Voltage Generator.

DIESEL ENGINES FOR OIL FIELD DRILLING

Harold F. Shepherd*

FOREWORD:

A report is requested on the present status of Diesel engines in the oil well drilling industry. This might be covered in a statistical article. Oil field statistics are published regularly in the engineering news journals of the industry, however, and it is believed that interested readers are continuously in touch with drilling progress.

An article with an economic slant might be attempted as "Steam vs. Gas Power vs. Diesel", but the conditions under which present rigs operate are so variable that any attempt to compare drilling costs in general on the basis of power cost would be folly. The broad principles are evident.

It is assumed that the most pertinent subject in the present situation is the engineering status of the Diesel engine models which have been used for drilling and, it is hoped, will soon again be in quantity production for oil field sale.

* * *

RELATIVELY few Diesel drilling engines have been supplied for domestic use during the war years. Most of the authorized production has been allocated to foreign operations for the development of oil fields in countries closer to the military fronts. By very reason of their small number, however, the engines delivered and in service have been under the very closest scrutiny by the oil field engineering staff, in field and at home. Certain rigs have been under constant laboratory observation by arranged collaboration with drilling organizations who anticipate benefits in improved life and performance when eventually they are allowed to expand their facilities.

**The author is chief of the National Supply Co. Research Laboratory of the Superior Engine Division at Springfield, Ohio.*

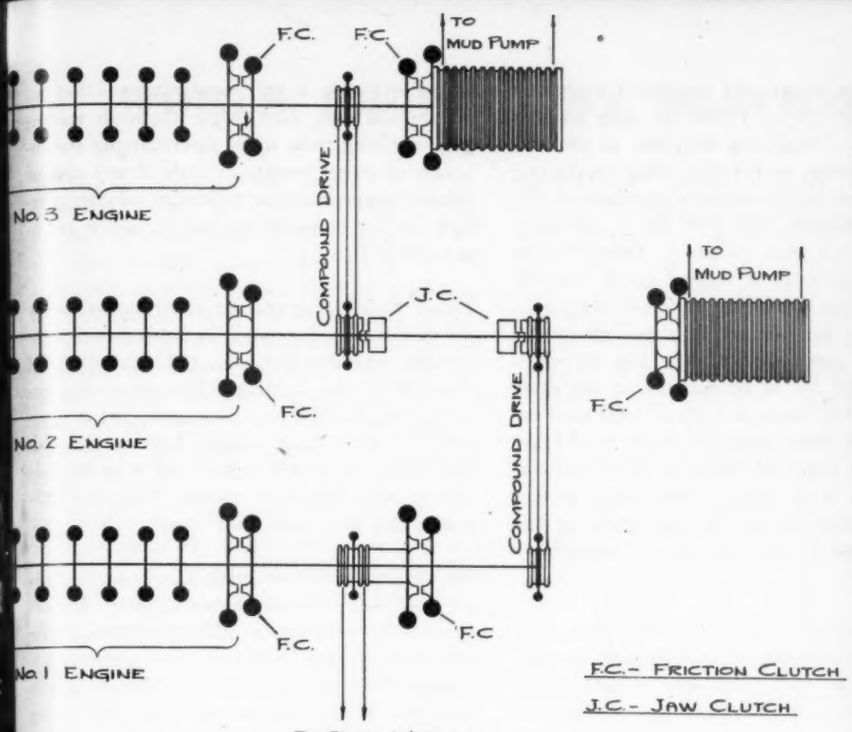
The present state of age and repair of Diesel drilling equipment is somewhat on a par with America's automotive fleet. Allotment of engines is awaited almost as eagerly as authorization to purchase cars, trucks and tractors. As in the case of automotive equipment, in which the first production will be, it is said, from pre-war patterns and tools, the small high speed Diesel engine may be, for a time, a prewar engine. This should not be the case with the larger Diesels now so much needed for economical prospecting and deep drilling.

When it is considered that there are, at the present peak, less than two thousand rotary drilling rigs in operation, that they range in power from 200 to 1950 hp and that only a percentage is Diesel engined, it is obvious that there has been, fundamentally, no such thing as a Diesel drilling engine. These engines must serve other uses as well to justify their engineering and plant cost. Since the better models of engines formerly sold for drilling are now being built for military and associated uses, in before undreamed-of quantities, facilities for their production now approach automotive standards. The searching type tests required by the U. S. Navy have required the best of laboratory and instrument facilities. These latter we now possess and have studiously applied. The oil industry will soon have the use of this experience. A brief review of the trend of improvement resulting from the developments of the war years is given in the following:

Figure 1 illustrates the mass elastic systems of the conventional type of mechanical rig transmission now in extensive use for deep drilling. Any engine may be declutched for idling in which case only its own rotating masses control the frequency of torsional vibration. Any engine may be clutched in, idling, with the rig clutches disengaged, which results in a second and lower natural frequency. One or both mud pump sheave clutches may be closed resulting in potential two-node as well as one-node systems with two additional frequencies for each unit.

All three engines may be compounded for hoisting, driving the draw works through chains. Chains, fortunately, do not seem to set up additional mass elastic systems between engine and engine nor do V-belts transmit the harmonics of the engines or pumps to any appreciable extent. From the foregoing it is apparently very desirable to couple the engines to the rig so flexibly that the rig masses are unable to influence the frequency or energy of the vibratory torque natural to multicylinder engines, thus reducing the vibration possibilities to one problem.

Early light rig transmissions probably isolated the engines successfully by reason of the lack of torsional rigidity of their shafting just as the rear drive and wheels of a motor car are isolated in low frequency relation to the engine by the long slender propeller shaft. However, rig shafting is subjected to heavy transverse loads and the tendency is to make it very stiff consequently other and calculated means of isolating the engine rotating systems from those of the rig transmission are being considered. Two National rigs under laboratory observation are at present drilling with torsionally flexible power take-off couplings of very low frequency. It will



SHAFT SYSTEM — DIESEL MECHANICAL RIG

Figure I

Figure II—National Diesel Fitted with Bonded Rubber Damper.

be understood that the natural frequency of the engine system should be as high as possible so that the engine operates below potential critical speeds. The take-off uniting the combined system should be very soft, its potential critical speeds being below the operating range.

Adequate instrument work has been done to demonstrate the correctness of these principles. Life tests are now progressing into the second year with commercial and modified commercial couplings with good results. Various other couplings are under endurance tests in the laboratory where the relation between engine and dynamometer systems may be adjusted to test for working stress or frequency.

The drilling engine, like the automobile engine, usually has an overhung flywheel. It is not feasible to use outboard bearings with a skidded unit. The detection of wheel shimmy, which may be critical and destructive, poses a problem for which no suitable commercial instruments have been made.

Electrical recording apparatus for this purpose was developed in the laboratory for investigation and correction of generator ventilating fans. This has been applied to drilling engine flywheels of extreme dimensions, light and heavy. Some of the resulting designs have been under field test in deep drilling for a year. Application of the principles developed will certainly prolong the service life of bearings and of the crankshaft itself.

All types of hydraulic couplings and torque converters have been applied to rig drives. Reasons for their use vary. The driller may desire such drives for use in keeping a strain on pipe or line when fishing, or for preventing the addition of the engine mass inertia to the torque when tools or pipe freeze in the hole. He may find the slip characteristic useful for driving mud pumps at the final stages of cementing.

The engine builder may reasonably expect adequate isolation of the engine torsional system from the rotating masses of the rig when hydraulic drives are applied. Careful tests show that there is no measureable transmission of engine harmonics through the hydraulic system if the fundamental rolling amplitude or firing impulse be expected such as the fourth order in eight cylinder four cycle engines. Even these latter are made harmless. Thus the frequency of the engine system with filled coupling does not change as rig elements are engaged or disengaged.

As an offset to this, couplings in the past have been vastly too heavy. It is believed that this situation has been corrected and would have been corrected long ago had steel and tools been available for making pressed and welded assemblies such as certain automotive fluid drives. The disadvantage of the heavy fluid coupling is that when driven by the engine through a torsionally rigid connection, the natural frequency of the system is lowered as much, perhaps, as it would be by direct drive to the rig transmission itself. The present expedient is to drive the fluid coupling through a torsionally flexible mechanical coupling.

In considering the amount of weight reduction desired it should be remembered that frequency as related to mass is a square root function; also that the relation between the crank system masses and the drive masses of flywheel, clutch, and hydraulic coupling positions the node. Roughly halving the rotating mass at one side of a node raises the frequency only as the square root of 2 or 1.41 times 41%). Consequently, the trend is for the lightest practicable hydraulic units.

Separate Diesel-electric drilling barges have been used for the past twelve years for drilling in the deeper tide water and lake locations. Some generator and motor control systems employed are similar to those which have been used in Diesel-electric locomotive drive for many years. The driller's control varies the engine speed so that the engine is worked at an efficient mean effective pressure while generating the required horsepower or kilowatt energy to overcome the load resistance. Others use constant generator speed and vary generator excitation only to control voltage and motor speed.

The simplicity of the presently proposed systems, from a mechanical viewpoint, is to be appreciated. Early designs in which one or two generators and a direct coupled exciter were strung out on the same shaft line as the engine present involved problems for the mechanical designer in that two or even three nodes of torsional vibration were possible. A single generator with V-belt drive for the exciter is ideal.

Whether the generator for drilling is to be of the single bearing type, with a laminated (Thomas type) flange coupling to support and drive the generator as in railroad or submarine practice or a two-bearing unit with a torsionally flexible coupling, remains unsettled. It seems that the combination of an independent generator with two bearings and a rather universally flexbile coupling is preferred for the reason that rig foundations and even barge foundations offer no certain facilities for aligned support of the engine and generator.

From the transportation viewpoint the latter is certainly preferable since the units are loaded on trucks by the simple expedient of lifting one end of the skid on the truck winch line until it comes over the tail. In this necessary operation

considerable strain might be thrown on a supposedly rigid assembly which, however, was designed for use and not for transportation.

Most engines of the automotive type having six or more cylinders, are now fitted with torsional vibration dampers. Although numerous attempts were made before the war to fit such dampers to larger engines, the types employed proved to be short-lived, ungainly and often erratic in performance. The bonded rubber damper has survived tests for fitness and applicability in which purely mechanical dampers failed. Its first cost and, consequently its replacement cost, are low. By small changes of mass or stiffness it is readily adapted to the variety of conditions imposed by driven machinery of various types.

Fig. 4 shows a bonded rubber damper in place on a Diesel-electric generator set, of the general type used for drilling. Two such dampers are now undergoing endurance tests in a Diesel industrial locomotive, in which service the cycles are intermittent and repetitive, and in that way similar to the operations of drilling. The basic engine has been in use for drilling for some years in the U. S. and in foreign fields. The engine alone requires no damper but should the attached masses, extending the torsional system, so lower the natural frequency as to introduce criticals, as has happened, suitable dampers are available.

In the past it has been the custom to mark dangerous critical ranges on the tachometers in red so that they may be avoided. Unfortunately the tachometer and its drive are the first to suffer from torsional vibration. The instrument, should it become inacurate, leads into danger rather than away from it. The present aim is to eliminate "red zones" entirely from the range of speeds used for the various operating requirements of the rig.

Extended use of the electro magnetic torsiograph together with the harmonic analyzer has immensely facilitated the development of dampers in this laboratory. Analysis which once consumed weeks of time by mathematical means are accomplished in a day with this apparatus. The proofing of dampers becomes a routine matter rather than a major venture into physical science.

Two 125 hp. or 150 hp. engines, not always compounded, suffice for development drilling up to 3000 or 4000 ft. For general drilling requirements, however, at over 4000 ft., bigger engines with selective compounding are the order For deep drilling, the time consumed in the hoisting operations of lowering the bit, in stages of three joints of drill pipe to the working face of the hole and retrieving it for replacement in like manner becomes a very important factor. Since a 9000 ft. hole will use 100 stands of pipe and an 18000 ft. hole 200 stands of pipe, rapid hoisting is of utmost importance.

The drilling string and associated equipment used recently for a 15,000 ft. hole weighed 250,000 lbs. Neglecting buoyancy as probably offset by friction, to lift this weight at the rate of 100 ft. per minute requires very close to 750 hp. This suggests that 1000 hp. at the draw works motor is none too much. Other services used while going in or coming out of the hole are mud pumps for mixing mud and filling hole, rotary drive for unscrewing pipe, lights, compressed air, water service, etc. The rig which requires 1000 hp. to be available at the draw works may well have as much as 1600 total engine hp. the latter certainly, if electrical losses in generator lines and motor are to be compensated. This is the deep drilling power picture for the moment but estimates are going up and two thousand or more hp. may be applied before long.

Since any unit of a rig should not weigh more than fifteen to twenty tons for haulage on commercial trucks and compliance with highway load limitations it is evident that drilling engines of high power, particularly when the generator weight is added to the unit, should gain their rating without any great increase in cylinder dimensions or overall dimensions over those at present producing 250 to 300 hp. on the heavier rigs. This suggests exhaust turbo supercharging.

This type of supercharging has won its place in pipe line work after six years, the first of which were not too happy, partly because the inventor's advice was not scrupulously followed. The same is true of locomotive work where Buchi type supercharges have been in use in the USA for about seven years. During the first year certain antifriction bearings proved unsuited to the service and were replaced by ingeniously lubricated plain bearings which have been satisfactory. The author's company has furnished some seventy odd sets of high powered supercharged engines during the war years without a single distress case. Also several smaller units of a size suitable for drilling, the basic engine of which has long been used for that purpose. Such units would shortly be offered for drilling service. This will result in a fifty percent increase of power with a very moderate addition to weight and size. Due to the thorough scavenging resulting from turbo supercharging the increase of power results in little if any rise of exhaust temperatures or maximum cylinder pressure and no apparent increase in engine maintenance cost.

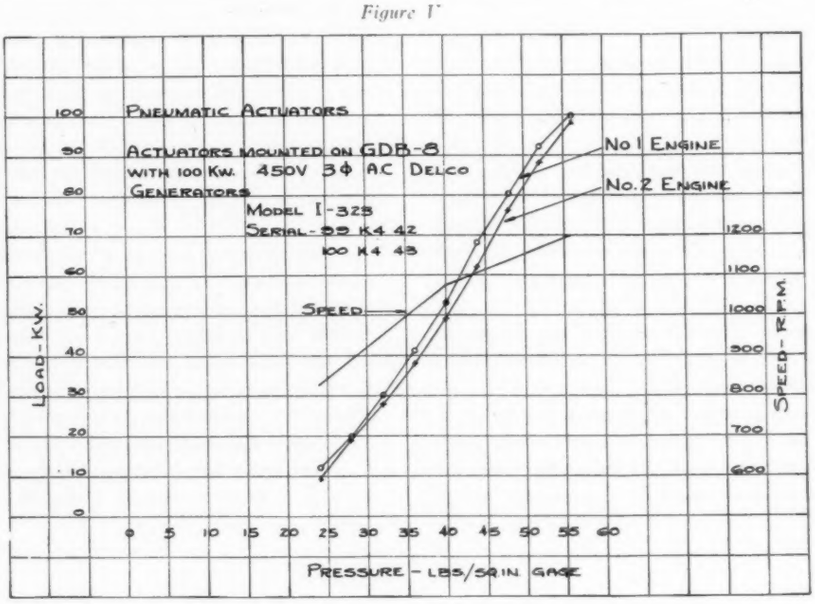
Diesel drilling engines are speed-controlled by the driller from his station by hand throttles for the continuous operations and by a foot pedal "accelerator" for hoisting. The connections between the throttles and the engine fuel or governor controls have usually been mechanical, resembling the sprocket chain and wire controls used in ships' telegraph systems. Rods and bellcranks also have been used.

Both hydraulic and pneumatic pilot house controls are now used in many ships and these are candidates for controlling drilling engines. The pneumatic systems have some very practical advantages chief of which are: (a) The air supply itself may be used to clean the connecting tubing for reassembly after it has been dismantled for moving; (b) Small leaks do not affect accuracy of control if the air supply is ample.

It is difficult to evaluate the distribution of load between Diesel engines when compounded. On the hoisting cycles the intervals are too short to make a determination by comparing exhaust temperatures. For laboratory test purposes pneumatic controls were fitted to two Diesels driving alternators operating in parallel. The results are shown in Fig. 5. This is considered highly satisfactory performance. Laboratory tests have warranted standardization of pneumatic controls for production.

While only national emergency materials have been available for oil field machinery production the builders of Diesel engines have been gaining volumes of experience with all the more resistant bearing materials in conjunction with shaft journals of various materials and hardness. A great variety of cylinder liner materials and treatments, good and indifferent, have been tried and evaluated. The NE materials in some cases have done remarkably good work.

Figure 5


PNEUMATIC ACTUATORS
ACTUATORS MOUNTED ON GDB-8
WITH 100 KW. 450V 3Φ AC DELCO
GENERATORS
MODEL I-323
SERIAL-99 K4 42
100 K4 43
No 1 ENGINE
No. 2 ENGINE
SPEED
LOAD - KW.
SPEED - R.P.M.
PRESSURE - LBS/SQ IN. GAGE
0 5 10 15 20 25 30 35 40 45 50 55 60
0 10 20 30 40 50 60 70 80 90 100
600 700 800 900 1000 1100 1200

WORLD PRODUCTION REACHED NEW HIGH IN 1944

WORLD production of crude oil during 1944 made up the decline that took place during the two preceding years of war and surpassed the previous high record of 1941. It is still impossible to obtain exact statistics of output in Axis countries or those under Axis control but in these cases approximations based on the best available information are given. The important changes that have taken place in the past year, however, have occurred in countries from most of which reliable reports are obtainable.

Production of roundly 2,598,000,000 bbl. represents a gain of 351,000,000 or 11.2 percent over 1943. Noteworthy increases were recorded by the United States, 177,000,000 bbl.; South America, 102,000,000 bbl.; the Middle East, 38,000,000 and the Soviet Union 30,000,000. This reflects substantial improvement in the oil supply of the United Nations and has been an important contribution to their war activities at a time when military requirements were expanding at a rapid rate.

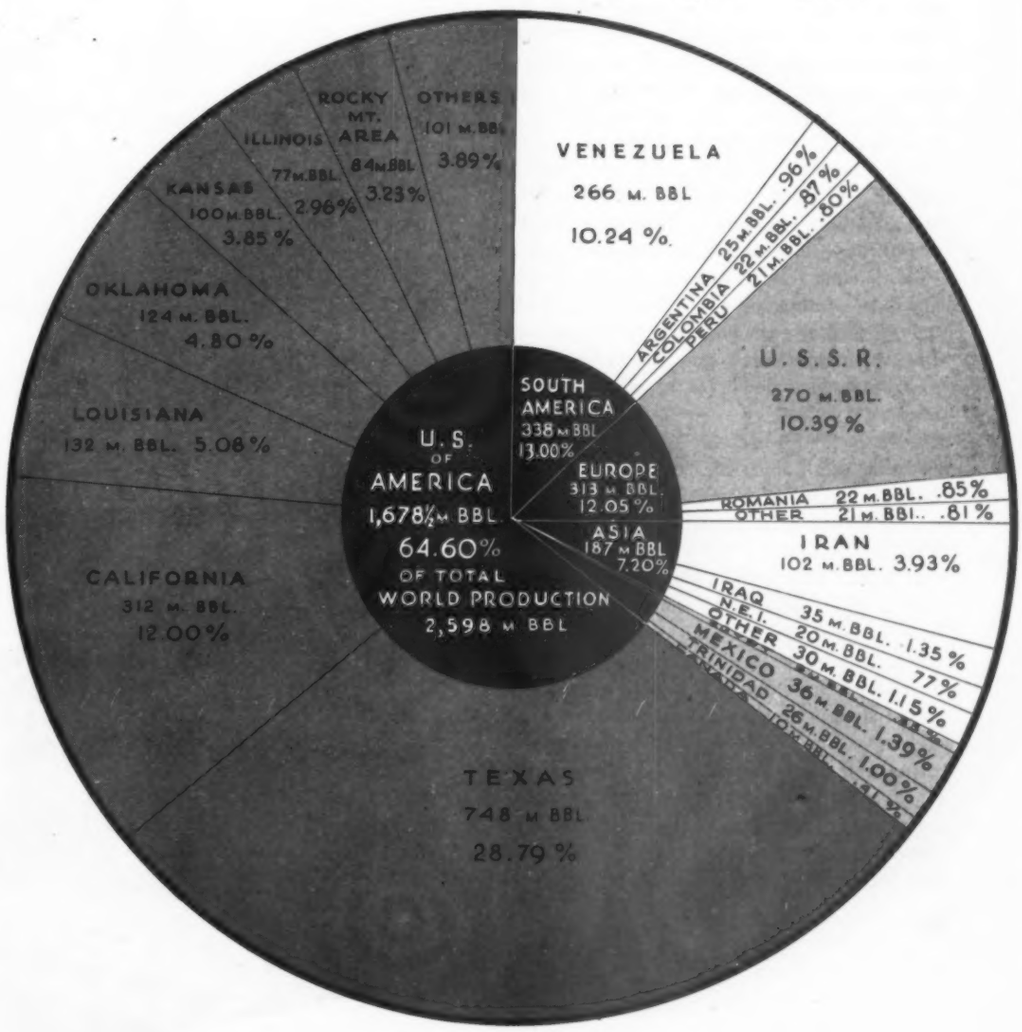
On the other hand the petroleum resources of Germany have shrunk disastrously during the year. Control of Romanian and Polish supplies has passed entirely out of Nazi hands. At the end of the year the Hungarian fields and the smaller deposits of Czechoslovakia were threatened by the advance of the Russian armies and were no longer available to Nazi use. As a result of the narrowing range of Hitlerite authority the only natural petroleum that Germany can depend upon is that produced in former Austria and within the Reich itself, possibly 12,000,000 bbl. yearly or less than three days output by the United States. Supplementing this is whatever remains of the German synthetic oil industry for which no closer estimate can be given than that of military observers who believe that as a result of constant Allied bombing of these plants they are capable of producing no more than 20 percent of their normal capacity or perhaps another 6,000,000 bbl.

Some further increase in production is likely to take place during 1945. In the United States it will hardly be possible to raise output much above the 1944 level since practically all fields except a few in isolated areas that lack transportation facilities are now producing at or above their maximum efficient rate. If daily output can be maintained at the current figure of approximately 4,700,000 bbl. daily, the gain in comparison with the year just ended would be roundly 35,000,000 bbl. or percentagewise only about two percent. In other regions, however, such as Venezuela and Colombia in South America, in the Middle East and the Soviet Union greater relative increases are to be looked for as a result of activities now under way.

Additions to refining capacity at Abadan, Bahrein and Haifa and completion of a new plant now under construction in Saudi Arabia will permit more of the production available in the Persian Gulf region to be converted into finished products near the point of origin and will make it possible to utilize these for military use either in Europe or in the Pacific. Restoration of the Soviet refineries destroyed during the Nazi invasion is well under way and a further increase in Russian production is to be expected. Daily production in the Caribbean area is counted upon to exceed a million barrels daily during the current year. With increased output from these various sources it appears probable that world production may reach a new high in 1945.

WORLD OIL PRODUCTION—Thousands of Barrels

	1941	1942	1943	1944
NORTH AMERICA				
United States	1,405,830	1,386,640	1,505,693	1,678,500
Canada	10,003	10,350	10,100	10,500
Mexico	41,200	32,995	33,795	36,000
Trinidad	21,210	21,500	22,000	26,000
	1,478,243	1,451,485	1,571,588	1,751,000
SOUTH AMERICA				
Argentina	21,641	22,375	24,400	25,000
Colombia	24,442	10,590	10,580	22,500
Peru	12,845	13,625	14,500	21,000
Venezuela	222,902	156,000	182,550	266,000
Other	1,562	2,350	3,000	3,500
	283,392	204,940	235,030	338,000
EUROPE				
U.S.S.R.	242,150	214,000	240,000	270,000
Romania	40,560	37,500	36,500	22,000
Other	12,937	16,480	16,325	21,000
	295,647	267,980	292,825	313,000
ASIA				
Bahrein & Saudi Arabia	12,717	12,600	12,750	17,000
Iran	78,035	75,000	78,000	102,000
Iraq	12,650	14,500	25,350	35,000
Other	81,685	18,250	24,800	33,000
	185,087	120,350	140,900	187,000
AFRICA				
Egypt	7,659	8,750	9,100	9,000
WORLD TOTAL	2,250,028	2,053,505	2,249,443	2,598,000



MORE DRILLING RIGS AT WORK BUT OPERATING RATE IS LOWER

By Brad Mills *Secretary, American Association of Oil Well Drilling Contractors*

Time Required for Wells of Average Depth Increased by Loss of Experienced Workers and Shutdowns Due to Lack of Parts and Materials—Combined With Other Factors Has Caused Sharp Rise in Costs.

DRILLING operations under current conditions are being carried out with a reduced efficiency that has been occasioned by a number of circumstances. The usual "war" problems are involved, and in addition many handicaps not common to other industries are present. Since January 1, 1943 the number of active rotary drilling operations in the United States has increased from about 750 to around 1800, and cable tool operations have increased also. It is remarkable that an industry so hard-pressed for skilled workers two years ago has somehow found the extra manpower to increase operations more than 140 percent.

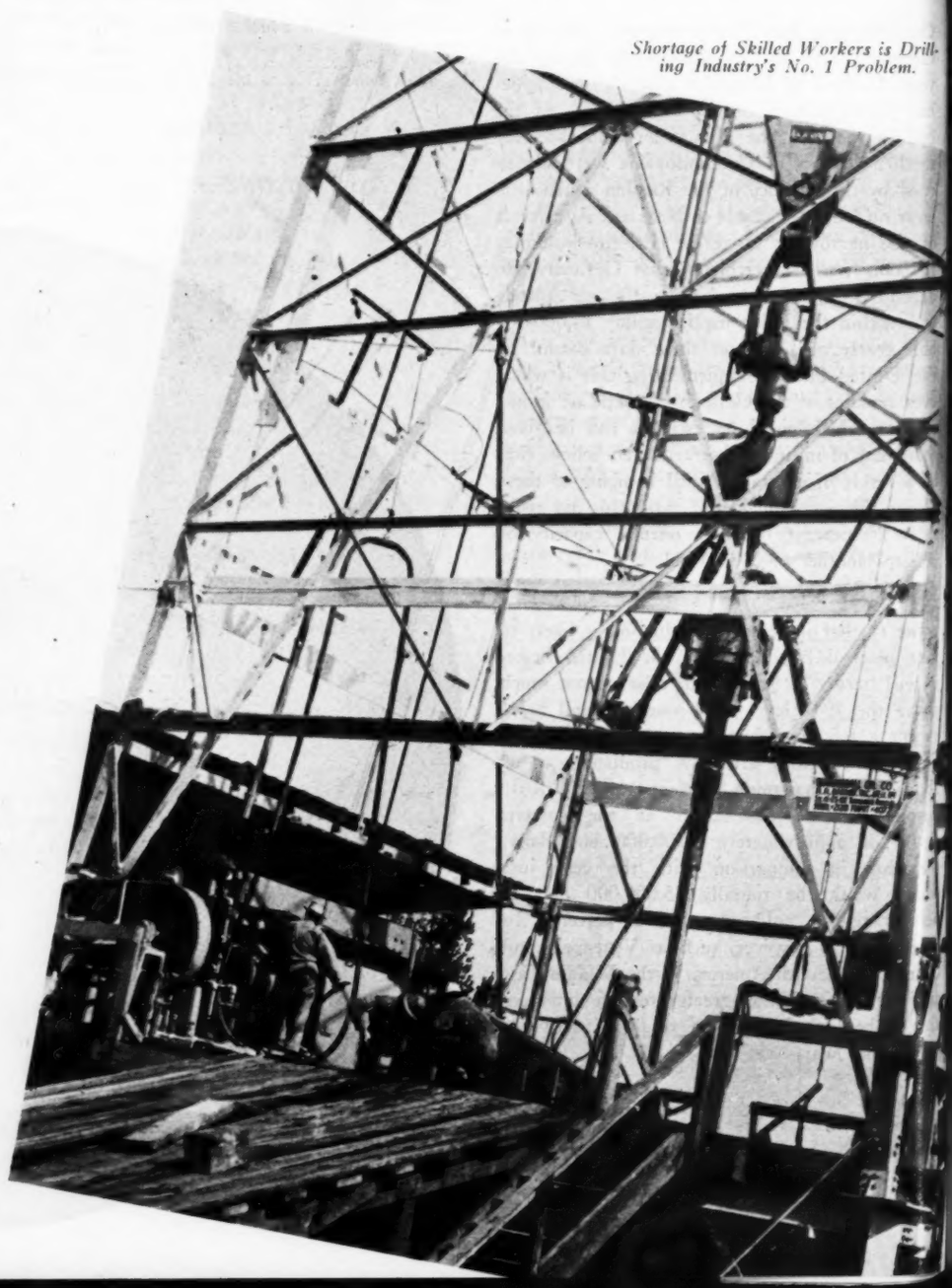
Overall drilling efficiency is difficult to calculate, but it is easy to see that 1800 rotary rigs are not now drilling at their best rate under normal conditions. In 1941, when about 31,500 wells were completed, the maximum number of rotary rigs in operation at one time was only 1275. In 1944 the number ranged from a minimum of about 1275 to 1850 and averaged about 1525, yet only 24,000 wells were completed. Thus it is obvious that a much larger number of rotary rigs was required in 1944 *per well* than in 1941. Of course, cable tool wells were an important part of the total completions in 1944, but the number of rotary wells completed per rig still was much lower than in 1941 or 1937. In all fairness, it should be mentioned that well depths have increased since the first part of 1941, but not enough to offset the loss in drilling time. Drilling programs have changed also, but formations encountered in 1944 and early 1945 operations were not largely responsible for the slowing down of the average drilling rate.

We hear much about the "overall efficiency" of drilling operations of today. One drilling contractor thinks it is about 64 percent of "par". This means that for every 1,000 feet of hole that would have been drilled in 1937 or 1941 with a given amount of effort, only 650 feet now is being drilled with that same overall effort. "Efficiency" is a difficult quality or factor to measure, since many intangible items are involved along with the more tangible ones. When an elapsed time of 45 days is required to drill a type well that was drilled in 30 days in 1941, the *time* increase is 50 percent, but the cost increase may be even more over 1937 or 1941 operations of comparable scope. The relationship between "cost" and "efficiency" would remain constant if neither was a variable. However, efficiency is somewhat of a fixed factor, while cost is a distinct variable. This means that as costs per day increase, only above-normal efficiency will prevent an overall cost increase.

There are many reasons why drilling costs do not necessarily increase in direct proportion to the increase in drilling time. Present daily operating costs are so much higher than those of 1941 that any increase in drilling time normally represents a "double" increase in drilling costs. Thus an increase of 35 percent in drilling time may represent a 35 percent increase over former drilling costs, plus the increased daily costs. Labor costs of today are much higher than those of 1941 because of (1) higher flat rates per hour; (2) additional overtime payments, and (3) increased drilling time on the average well. We know that such intangible factors as the inefficiency of green help and fluctuating crew morale materially increase labor costs, but such inefficiencies simply are carried over into the overall picture.

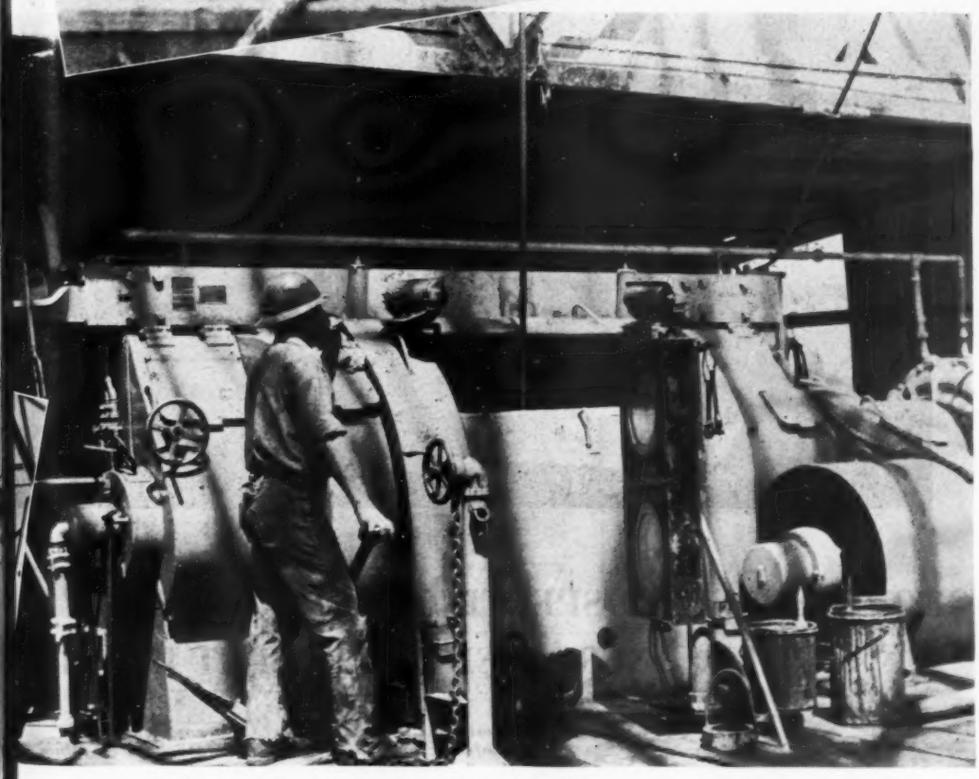
The drilling industry is suffering most seriuosuly from lack of manpower, shortage of materials, poor transportation service, and an acute housing shortage in many areas. The various government agencies, particularly PAW and WPB, have been helpfull in obtaining nominal supplies of materials, but shortages have plagued operators everywhere. PAW also has assisted in various manpower squeezes.

Slow to establish its true essentiality status following Pearl Harbor, the drilling industry has been trying since early 1943 to recover from the inferiority complex it acquired in 1942.



Shortage of Skilled Workers is Drilling Industry's No. 1 Problem.

Speed in Drilling Depends on Know-How of the Crews.



Training and Experience Are Needed in Complicated Business of Drilling.

During the first year of the war thousands of skilled oil well drilling crewmen drifted to shipyards, the aircraft industry, and other defense projects, not to mention heavy losses through selective service. Drilling operations were at such a low ebb through most of 1942 that contractors were force to stand by and see many of their skilled men go to other war industries offering full-time employment. That exodus subsequently brought about a serious skilled labor shortage that still exists in every district.

Since early 1943 the drilling industry has tried hard to get its place in the sun through rightful claims of extreme essentiality. During 1942 a large percentage of oil well crewmen did not realize they were doing war work, and even the selective service boards in many districts were not oil-conscious. The petroleum industry itself was largely responsible for the early failure to do proper public relations work, but the perspective generally has changed and every phase of field operations has been recognized as critical or essential.

PAW has asked for 27,000 new wells in 1945, of which some 6,000 should be wildcats. Will the drilling industry be able to complete this ambitious program, representing a 16 2/3 percent increase over the 1944 schedule? The answer largely depends on the ability of drilling contractors to obtain necessary manpower and materials.

Most contractors are operating at what they call "capacity". This is simply a way of saying that they can't put more rigs to work until more skilled crewmen and additional materials are made available. Dozens of rigs are at least temporarily idle because of such shortages. Gradually additional rigs were pressed into service during the past six months, but many of those rigs had been classified as old and unable to compete with newer and more efficient outfits.

From 18 to 20 men are employed on or in connection with each active rotary drilling rig. Obviously around 35,000 rotary drilling crewmen and supervisors are required to carry on current operations. The loss of any appreciable percentage of these skilled crewmen will necessitate recruitment of at least a similar number of good men, if 27,000 wells are to be completed this year.

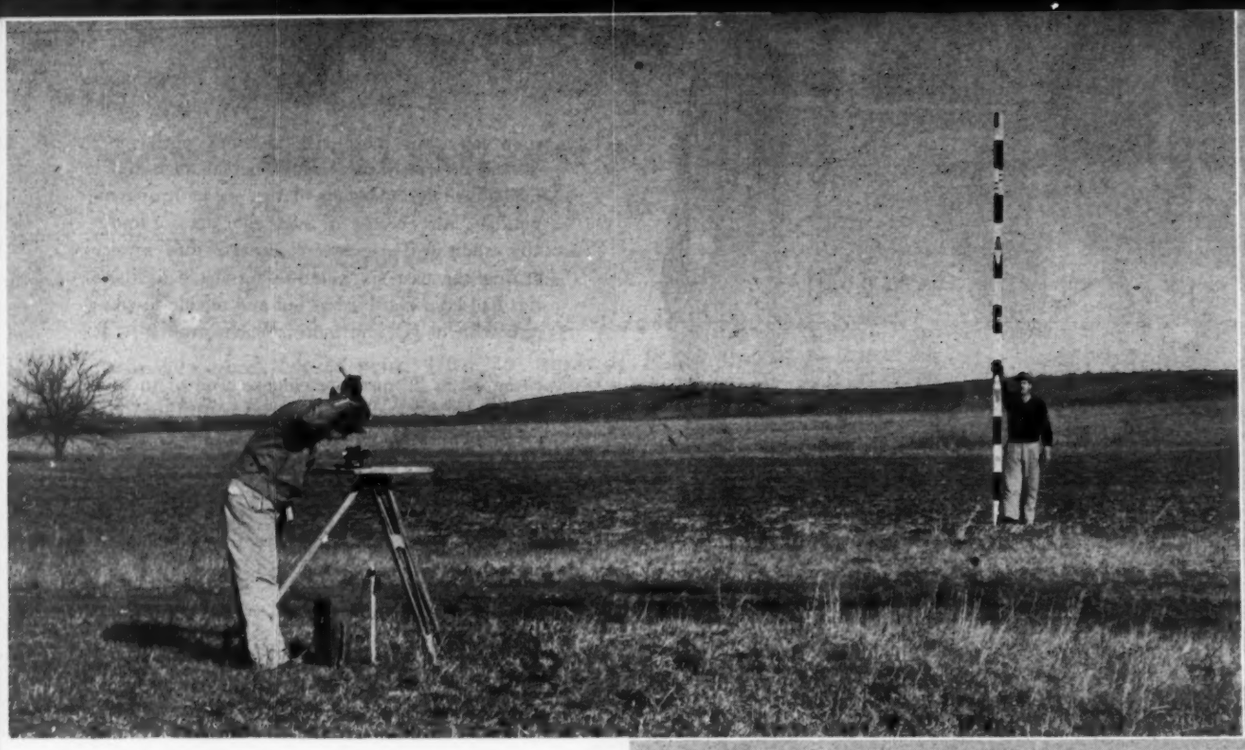
Thousands of crewmen have been trained or partially trained by drilling contractors since 1941. A training period of a year is required to make an efficient floorman, while a longer training period, from two years up, is required to make a derrickman. Many new drillers were graduated upward during 1943-44, but the training period for this job ranges from four to six years.

The most acute need for drilling crewmen exists in the classifications of floormen, derrickmen and enginemen. These jobs must be filled before a rig can operate, yet their true essentiality has not been fully appreciated or recognized. Thousands of former drilling crewmen now are working in shipyards, aircraft plants and various defense industries, and they are regarded as choice manpower material, since they have had sufficient mechanical training to make them readily adaptable to almost any mechanical job as semi-technicians. War plants also pay high wages and the ex-crewman is able to live at home with his family.

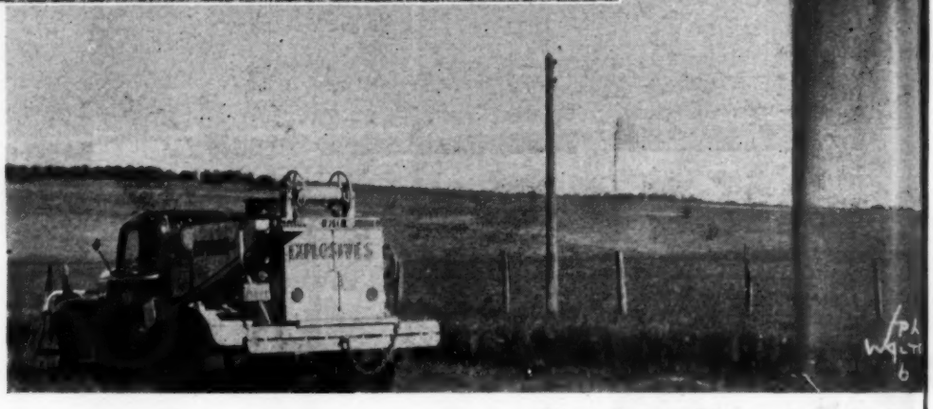
When all factors are considered, we come out with a genuine shortage of skilled men needed to do an urgent drilling job. Every effort is being made to encourage men to stay with their jobs, and essentiality and patriotism are stressed as prime reasons why they should not change jobs needlessly. If the full 1945 program is to be carried out, very nearly all of the skilled men now employed must give a "command performance" far above that required to do the job in 1944.

The overall drilling program is being retarded to some extent by shortages of certain materials, particularly drill pipe, tool joints, internal combustion engine parts, wire lines, and various repair parts. It is not unusual to shut down an entire drilling rig because of breakage of a very small part. Some drilling contractors believe that the lead time for ordering drill pipe should be reduced to correspond with the lead time for other oil country tubular material, and that the mill stock allotments for drill pipe be increased in proportion to the rotary drilling activities in

(*Continued on page* 106)



Above: Members of Seismic Crew in Field Survey.



Right: Setting Off Shot in the Field.

Photos Courtesy Seismograph Service Co.

GEOPHYSICAL PROSPECTING INCREASED 30 PERCENT IN 1944

By C. A. Heiland *President, Heiland Research Corporation, Professor of Geophysics, Colorado School of Mines*

IN the third year of war, geophysical oil exploration broke all records to keep pace with the demand for increased reserves. Geophysical prospecting for strategic and other minerals also grew in scope.

The trend in geophysical oil exploration throughout the war is indicated in Fig. 1. This figure resembles the one presented in the last annual review issue of M&M (February 1944, p. 62), corrected for data on operations in the last months of 1943 and extended into 1944.

The average number of geophysical oil prospecting crews in the field in 1944 was 451, whereas the total in 1943 was 340. An upward trend in the use of all geophysical methods is clearly evident throughout the year. Seismic operations were 67 percent, gravimeter surveys 28 per cent, and other methods 5 per cent of the total. Seismic reflection and refraction crews increased 18½ per cent over the 1943 average, gravimeter operations increased 73 per cent, and other methods gained 92 per cent. The increase in seismic and gravimeter operations, particularly the latter, is probably due to an increased production of equipment and the organization of new service companies. Miscellaneous methods gained largely through a revival of magnetometer work, and an increase in the use of torsion balance and electrical equipment. In comparison with the prewar average of 1941, it is noteworthy that seismic operations increased 58 per cent, gravimeter operations 88 per cent and miscellaneous other methods gained as much as 283 per cent. Unfortunately the expansion in the number of geophysical crews does not indicate a proportionate increase in efficiency or in a real coverage, as will be brought out later.

Coincident with the expansion of geophysical field activities has been a marked increase in electrical logging operations, particularly when viewed in relation to drilling. The first inset in Fig. 1 shows well completions since 1941. In that year, 32,265 wells of all kinds were completed; in 1942, 20,825; and in 1943, 19,212 wells were drilled. At this writing, the expected number for 1944 is 24,400. The number of electrical well-logging operations was about 12,000 for 1941, 9000 for 1942, 11,000 for 1943, and it is expected to be about 15,600 for 1944. These figures indicate an appreciable increase in the acceptance of electrical well logging. In terms of total wells completed, electrical well-logging operations numbered 37 per cent in 1941, increasing to 43 per cent in 1942, to 57 per cent in 1943, and to about 64 per cent in 1944. In other words, by comparison with pre-war activities, acceptance of electrical logging had nearly doubled by the end of 1944.

The financial aspects of the expanded geophysical field activities are of more than passing interest. At an average monthly cost of $8000 for a complete seismic crew and a monthly cost of $4000 for a gravimeter crew with two surveying parties, the average monthly outlay of the industry came to nearly $3,000,000, figuring the monthly cost of the other miscellaneous parties at $2000. With an average figure of $300 for an electrical logging operation, the total expense for geophysical work was, in 1944, slightly more than $40,000,000 against $31,500,000 in 1943. This represents an increase of 28 per cent.

The influence of geophysics may be recognized in the volume and degree of success of wildcat drilling. For 1943 Dr. Lahee published the figures indicated in the tabulation given in Table 1, which clearly indicate the greater degree of success achieved by the application of scientific location methods, particularly geophysics, and geophysics in conjunction with geology.

Equipment of Reflection Crew Leaving for Foreign Survey.

Alabama, 11 crews; Florida, 13 crews; and Georgia, 3 crews. In 1943-44 the following Mississippi fields were discovered, largely by geophysical means: Heidelberg in Jasper County (discovery by Gulf Oil Co. on the basis of nosing in gravity contours). Cranfield in Adams Co. (seimic survey in 1942); Flora in Madison Co. (structure found in 1938 by seismigraph); Eucutta in Wayne Co. (partly on basis of gravity anomaly mapped by the Gulf in 1937, and a resurvey by seismograph); and Brookhaven in Lincoln Co. (seismic work in 1938 and 1940). Also discovered was the Gilbertown field (Hatchetigbee anticline) in Choctaw Co., Alabama (gravity survey).

The recent discoveries have led to a revision of the interpretation of geophysical results. It is now assumed that the supposed Selma reflecting surface upon which previous seismic interpretations were based, is actually Midway, and that the thickness of Selma limestone interferes with shooting for lower beds. Therefore gravity surveys are now given some performance particularly for the location of salt domes. Ten piercement-type salt domes were located by drilling in Mississippi in 1943, many of them on the basis of gravity work. Magnetic surveys are being used to locate structures controlled by igneous intrusions.

As mentioned in a previous review, Humble Oil's Gulf Coast Realty No. 1 in Collier Co., Florida was located on the basis of gravimeter work, after the Gulf Oil Co. had dropped the prospect following seismic and gravity work in 1938. Recently, Humble's Gulf Coast Realty No. 2 encountered salt and anhydrite at about 12,000 ft. depth.

Along the Texas - Louisiana Gulf Coast, geophysical exploration was as active as ever, with the usual high discovery rate. Probably all of the 29 discoveries made on the Coast in 1943 may be attributed to seismograph work, The twelve fields in Texas are: Chesterville and Ramsey in Colorado Co., Cistern in Fayette Co., Citrus Grove and Sugar Valley in Matagorda Co., Cottonwood in Liberty Co., Jacksons Pasture in Chambers Co., North Katy in Waller Co., Kirby in Liberty Co., Menefee and North Louise in Wharton Co., and Pinehurst in Montgomery Co., the latter rated a possibly important discovery.

Most of the seventeen Louisiana discoveries of 1943 were one-well fields, and are: Arnaudville in St. Martin, Bear and Fields in Beauregard; Church Point, Eagan, and North Richie in Acadia; Convent, Hester and St. James in St. James, East Gibson in Terrebonne, Hope Villa in East Baton Rouge, Napoleonville in Assumption, North Jeanerette in St. Marys, Pecan Island in Evangeline, Rosedale in Iberville, and Shuteston in St. Landry parish. Eight new oil and distillate fields were opened in southern Louisiana in the first half of 1944.

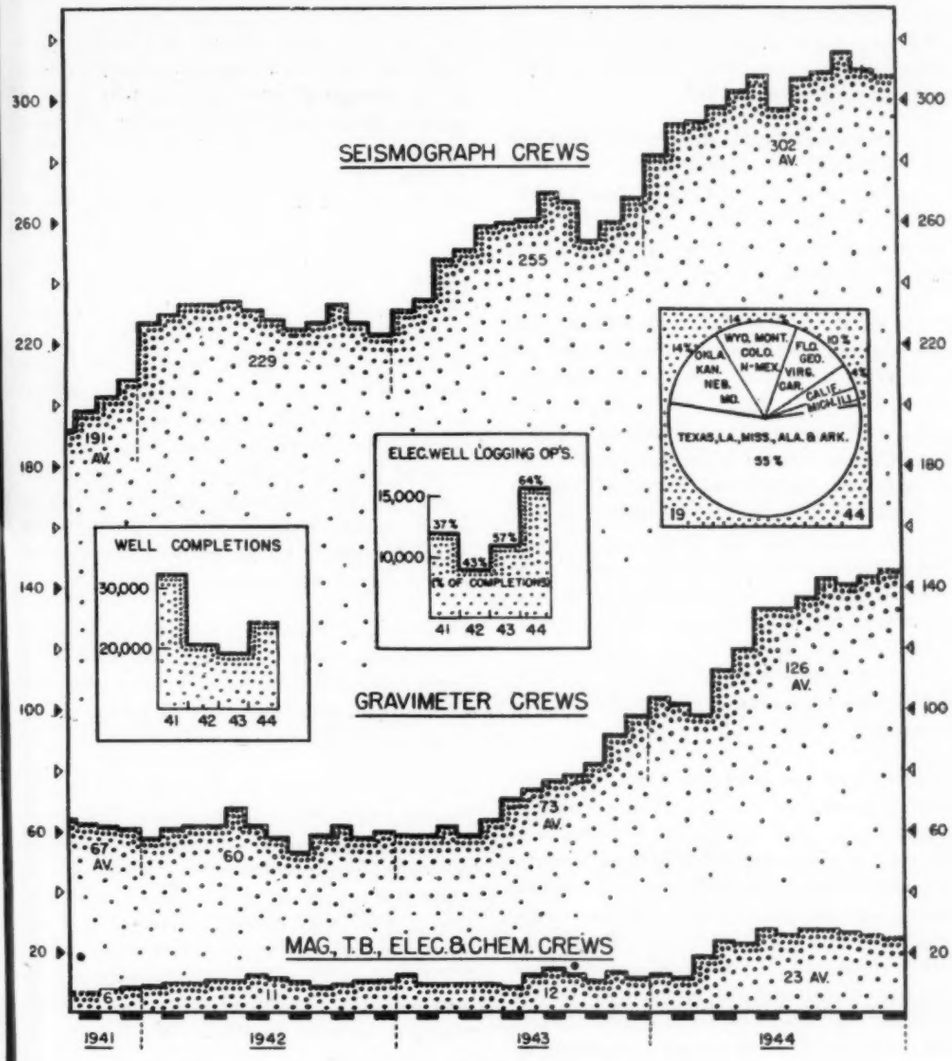


Fig. 1.

TABLE I.
Productive and Dry Wildcats by Methods of Location (1943)

Method of Location	Total Wells	Productive	Dry	Per Cent Productive
Geology	2239	411	1828	18.5
Geophysics	694	149	545	21.5
Geology and Geophysics	309	66	243	21.5
Sundry non-technical	523	23	500	4.5
Unknown	78	6	72	7.5
Total	3843	655	3188	17.0

Most significant of the developments in 1944 was the interest in the southeastern states following discoveries early in 1944 and late in 1943 in Mississippi, Alabama, and Florida — the Mississippi discoveries alone being estimated at 50 to 100 million barrel reserves. Vigorous geophysical prospecting and leasing is under way all along the coastal belt up the Atlantic coast through the Carolinas. This is reflected by the following approximate midyear figures: Mississippi, 47 crews;

In West Texas, the Mabee Pool in Andrews Co., the Sand Hills West in Crane Co., the Smyer in Hockley Co., and the Wheeler-Ellenburger in Winkler Co., were located by the seismograph, whereas the discoveries of the Clabberhill in Andrews Co. and the Russell pool in Gaines Co. are attributed jointly to seismograph and sub-surface geology. The Wheeler-Ellenburger and similar finds in Winkler Co. have stimulated seismic detailed mapping of deep Pre-Permian structures. Use of gravimeters is also increasing in this area.

The Goebel and Coquat fields in Live Oak Co. of South Texas were the results of extensive geophysical work in the Oakville fault zone of the Wilcox trend.

In the areas of the Bend and Muenster arches of North Central Texas, 24 producing wells were located in 1943 on the basis of seismograph work, and fifteen with the aid of the seismograph and subsurface geological information. The discoveries are in Archer, Clay, Cooke, Jack, Montague, Stephens, Throckmorton, Wichita, Wilbarger, and Young Counties. The Hardy field extension in Jones County was reportedly located by geochemistry. The Henderson field just southwest of the East Texas field was a seismic prospect, the Mansville field in Wood County was found on the basis of surface geology and seismic work; and the new Hope field in Franklin County is on a long anticline located by seismograph.

In New Mexico, subsurface geology and torsion balance were credited jointly with the location of the Fenton field in Eddy Co.

Geophysical activity in Oklahoma appeared to be somewhat on the decrease early in 1944. The East Otoe pool in Noble Co. was discovered by Superior Oil on the basis of seismograph information after the original test, located likewise on the strength of seismic survey made in 1936, was abandoned. On the east flank of the Seminole Uplift in Hughes County, a number of producing wells were located by the seismograph, as was the Roll well on the Ft. Hill reservation. After the discovery of the West Moore pool in Cleveland Co. on the basis of seismograph and gravimeter work, increased geophysical activity was seen in McClain, Grady, Cleveland, Canadian, and Kingfisher counties and other counties covering the flank of the granite ridge.

Twelve new pools were found in 1943 in western Kansas as a result of seismograph operations, the discovery percentage being about 18 per cent. (Brack, Farmington, Frisbie, Grunder, Rothgarn, Spangenberg, Syms, Van Lieu, all in Stafford Co.; Eveleigh in Barton Co., Hansen in Phillips Co., Leiker and Riverview in Ellis Co.) The number of pools so located was better than normal, but most of them of limited areal or productive extent.

In Nebraska, the seismograph was less successful. Fourteen tests located on the basis of seismograph information, and two drilled on magnetometer and soil analysis failed to produce.

In Illinois, the Bessie field in Franklin Co., Bogota in Jasper Co., Browns and Browns South, and Ellery South in Edwards Co.; Exchange in Marion Co., Johnsonville North in Wayne Co., Marine in Madison Co., and Mt. Vernon in Jefferson Co. were located by seismograph; the Covington South in Wayne Co., the Hill in Effingham, and the Toliver East in Clay Co. by geology and seismograph; the Markham City North in Jefferson Co. by gravimeter and seismograph; and the Belle River in Jefferson Co. by gravimeter and geology. Seismograph work declined toward the end of 1943. There was also some activity with gravimeters and magnetometers. Geophysical statistics on 1944 are not yet available; the number of successful wildcats in the 1st half of 1944 was about on a par with those in 1943.

First seismograph-located discovery in Michigan was the Shell Oil Co. Koth No. 1 (Pinconning-Fraser discovery) in Bay County; however, the second offset was unsuccessful. Seismograph work continued in the Thumb district and adjoining parts of the Basin.

In California, three new oil fields (Huron, Lanare, and Raisin in Fresno Co.) and six new gas fields (Colusa in Colusa Co., Ord Bend in Glenn Co.; Gill Ranch, Herminghaus, and Moffat in Madera Co.; and Thornton in Sacramento Co.) were found by the seismograph. Two oil fields (SE Greeley and E. Strand, both in Kern Co.) are attributed to geology and seismograph, and one gas field (Lodi in San Joaquin Co.) to the gravimeter and seismograph. The discovery percentage on seismograph plays was estimated as high as 27 per cent. These statistics apply to 1943, those for 1944 not being available as yet; the results obtained thus far in terms of additional oil reserves are said not to be encouraging.

Another significant development from the viewpoint of geophysical field activities was the increased interest in Wyoming and Montana. Development of these areas had been much retarded by an unfavorable heavy black type of crude and absence of production in large and seemingly ideal types of surface structures. But deeper drilling established the presence of a more favorable type of oil and the productivity of less prominent type of structure with smaller closure. About two thirds of Wyoming is occupied by basins on the edges of which the major oil and gas fields are located, and geophysical exploration by gravimeters, magnetometers, and reflection seismographs offer much promise in these areas. Additional stimulus has been provided by recent price increases in light oil and the equalization of black oil with the Texas crude. Wyoming incidentally, has had a high percentage of productive wildcats. In the past 3½ years, Wyomings' percentage of producers was nearly three times that of the national average, with Montana and southern Louisiana (about 2½ times the national average running close seconds.

Geophysical activity in Canada was mainly concentrated in Alberta and Saskatchewan. Some figures recently published on past geophysical work in Saskatchewan indicate that in 1940-41, about 11 million acres were survey by the gravimeter at an average cost of about half a cent per acre, and that better than 5 million acres were covered by the reflection seismograph at about 7c. per acre. At Jumping Pound, paleozic limestone was found at a depth of about 11,500 in a fault block where seismic surveys had indicated it. At the end of 1943, a structure outlined by seismograph was drilled in Hillsborough Bay on Prince Edward Island.

In 1944 an increase in geophysical activities also took place in South America. Socony-Vacuum had a seismograph crew and a gravity crew at work in Magdalena area of Colombia, and a second contract gravity crew (R. H. Ray) was conducting explorations in the Llanos region. Geophysical Service Inc. was running a seismograph survey for the Richmond Petroleum Co. along the Caribbean coastal strip. Shell Oil Co. completed arrangements for a seismograph survey of an undisclosed area with the United Geophysical Co. The Tropical Oil Co. had one of its gravimeter crews at work in the Llanos region. The Texas Co. completed a geophysical survey of its 127,000-hectare tract which it acquired in fee in the Teran-Guaguaqui area and expected to have three or four seismograph crews in the field soon. Phillips Petroleum leased approximately a million acres in the Magdalena River Valley and will soon proceed with geological and geophysical exploration.

In Venezuela, Richmond Petroleum Co. obtained concessions covering 1¾ million acres on the west side of Lake Maracaibo for exploration under the laws of 1943, and preparations for geological and geophysical exploration are well under way.

Under a contract with the Argentine Y.P.F., geophysical exploration is in progress in the central and southern Buenos Aires Province where gravimeters and torsion balances totaling four instruments were used in reconnaissance on 1-km. station grids with detailed follow-up by three refraction and reflection seismograph crews. Y.P.F. reports that a number of structures have been indicated and will be drilled on the most promising locations in 1945.

Reflection seismograph exploration was carried on in plains and the foothill regions near the Straits of Magellan in southern Chile, with reflections observed to below 4000 meters.

Word comes from England that search for new oil fields has been expanded as a result of successful development of pools in the Weald area, south of London. D'Arcy Exploration Co. and Anglo-American Oil Co. have been granted

licenses to conduct geophysical surveys and drilling tests in five new areas in the eastern and southeastern parts of the country. United Geophysical Co. reports that they now have one seismic crew operating in England.

A number of developments have taken place in the field application of geophysical techniques which deserve mention.

In some areas where difficulties were experienced with reflection shooting, there has been a return to the refraction seismograph, both for reconnaissance and detail mapping. Examples are certain areas in the Southeastern United States, previously mentioned while discussing the surveys of Mississippi and Alabama, and the Edwards Plateau region, on which a report was presented at the last A.A.P.G. meeting by Gillin, Alcock, and Arnett of the National Geophysical Co. In connection with seismic field techniques, reflection shooting is used more and more in coastal waters where conditions are favorable In the southern part of Louisiana, for example, such work has been carried as far out as 25 miles from the shoreline, according to Paul Weaver.

Relative to gravity work, there is a noteworthy tendency to conduct surveys more on a regional scope with attendant advantages in interpretation rather than to limit such work to isolated prospects.

Experimental and exploratory surveys with electrical methods are still going forward. The Elflex Co. continued its work with the low-frequency, transients to determine electrical resistivity conditions at depth on or near producing fields. Surveys made for the Independent Exploration and the Tide Water Associated Oil Co. indicated resistivity highs in the producing areas.

Soil analysis work is being continued on a moderate scale. S.J. Pirson reports that he is working on an improvement of his geodynamic method which is now operated by two other laboratories, and also mentions that one of the 1943 discoveries by Hanlon-Buchanan in Jack County, Texas should be credited to the application of this method.

On the statistics and technical progress in geophysical well logging, much detailed comment has been received from E. G. Leonardon and Dr. Weaver. The increased use of these techniques was discussed in the first part of this review. The spontaneous-potential dip meter is in considerable demand, and the number of such operations in 1944 was about double that in 1943.

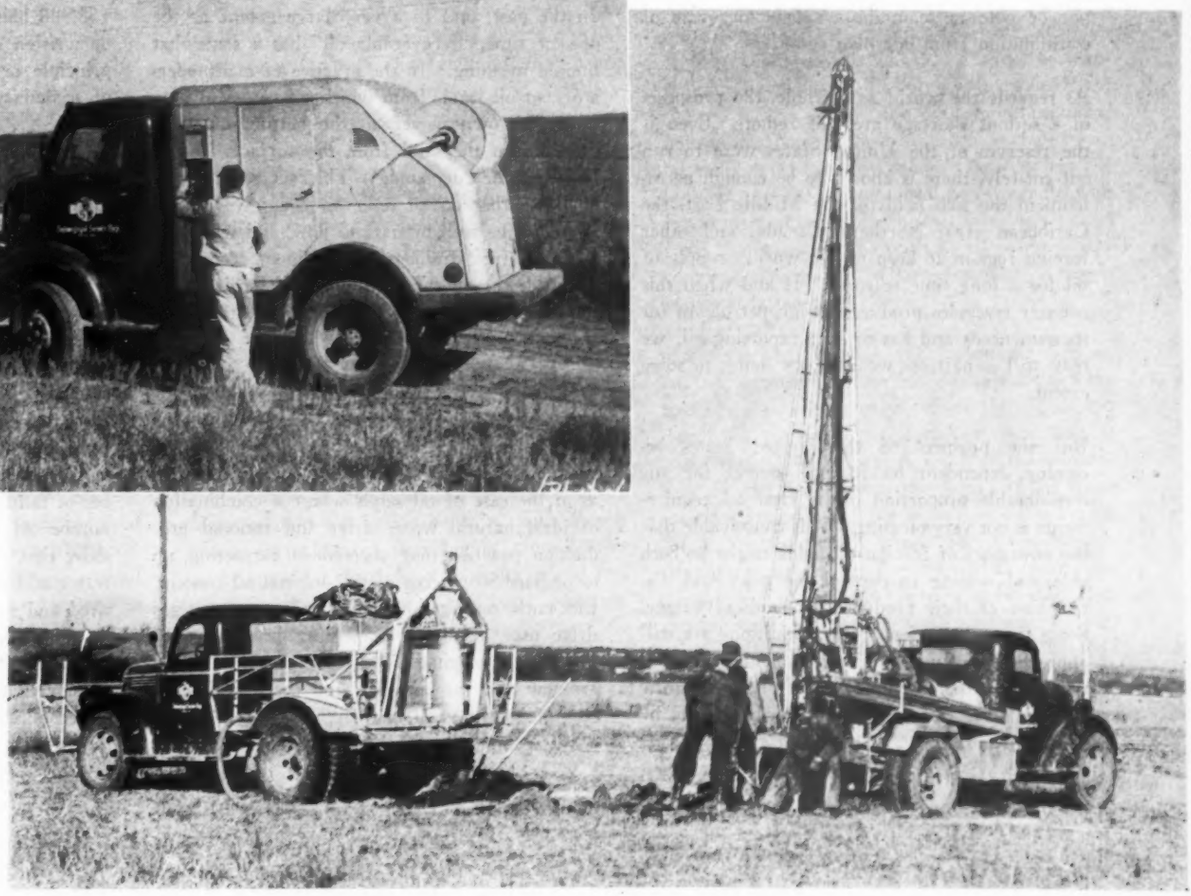
The Gamma Ray logging method is also applied more widely, as is the Neutron method. These two methods are most useful when both are run in the same well, and the Neutron is used to complement the information obtained from the Gamma Ray. The Gamma Ray is also used to find the distribution of radioactive substances introduced into a well for various purposes. When cementing a well, addition of radioactive material in the cement makes it possible to determine the distribution of the cement behind the casing. Gun-perforating equipment sometimes employs bullets which have been tipped with radioactive material in order to check the location of the perforations by a subsequent Gamma Ray survey. Radioactive material has also been introduced into fluids which are pumped into porous formations, and the relative penetration of this radioactive material in different parts of the porous formation gives an indication of their permeability.

Temperature logs are used after cementing pipe in wells in order to determine the distribution of the cement behind the casing; few of the oil companies are using this temperature log with the idea of studying geothermal gradients. It seems quite unfortunate that the pioneer work of Van Ostrand and others, which indicated a relation between geothermal gradient and geologic structure, is not being followed up by the making of geothermal logs on wildcat wells and extensions to accumulate further information on thermal gradients. The number of temperature logs run at present, and principally for giving information about cementation, is about 600 annually.

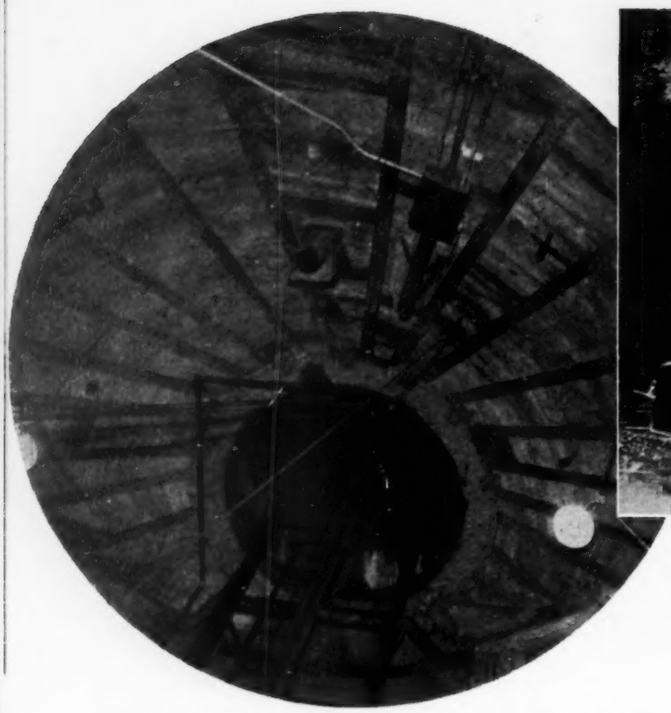
Footnote:

Condensed from a report prepared for A.I.M.E. and published in February review number of Mining and Metallurgy.

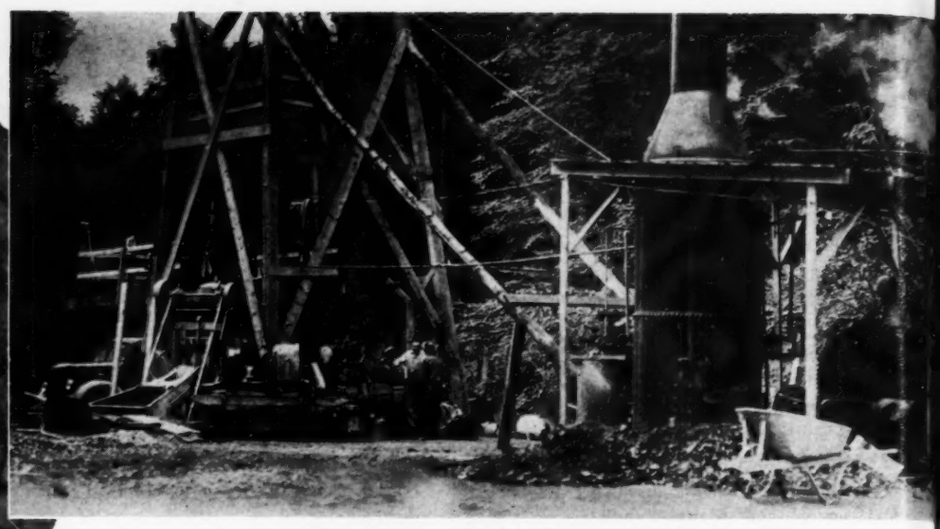
Seismograph Recording Truck.



Drilling Hole for Seismograph Shot.



Interior of Work Chamber Showing Shaft and Concrete Roof Reinforcement.



Surface Equipment Used in Excavating Shaft and Chambers.

New Moves in SECONDARY RECOVERY

By Dr. O. W. Willcox

NOW, more than ever before, the thoughts of oil men are turning to the problem of the future supply of natural petroleum, particularly as this problem affects the United States. The bald fact is that oil consumption in this country has been running somewhat ahead of additions to oil reserves by discovery of new oil fields. The discrepancy has not yet assumed alarming proportions, and with a little luck the trend might be reversed, but it at least suggests that under present methods and conditions we may not be able to maintain a satisfactory rate of consumption from our own resources.

As regards the world as a whole, the prospects of a serious shortage are still remote. Even if the reserves of the United States were to run out entirely, there is known to be enough petroleum in the rich fields of the Middle East, the Caribbean area, Northern Canada, and other foreign regions to keep up the world's supply of oil for a long time to come. If and when this country ceases to produce enough petroleum for its own needs and has to stop exporting oil, we may still import, as we are now doing to some extent.

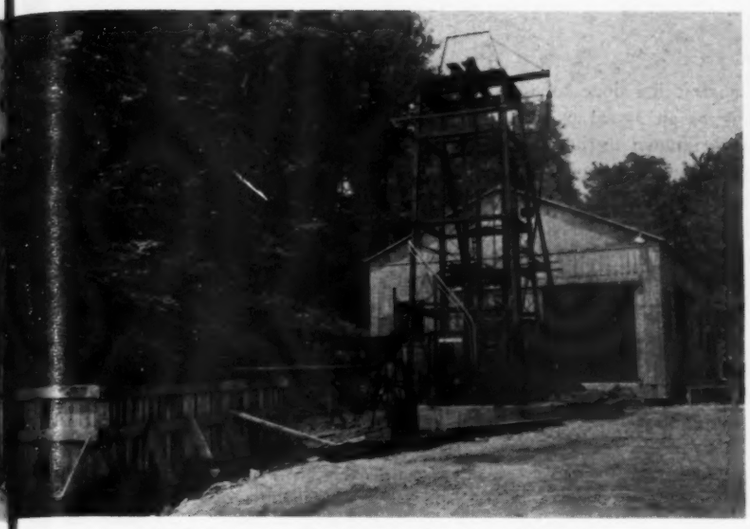
But the prospect of the United States becoming dependent on foreign sources for any considerable proportion of its vital oil requirements is not very pleasing. It is conceivable that the possessors of foreign oil fields might be both able and willing to control the price and distribution of their product to our disadvantage. Some forecasters of post-war conditions are still apprehensive of unilateral cartels in the world oil trade unless the economic clauses of the Atlantic Charter come into real effect which is as yet by no means certain.

The possibility that the United States may eventually become, more or less, tributory, under certain conditions, to foreigners for an essential portion of its supply of natural petroleum is just one of the reasons why our oil men, who are the custodians of this division of our national wealth, should accept the obligation of seeing to it that our developed reserves are utilized to the fullest possible extent; and in this effort they should receive all necessary and advisable help from the public authorities.

Full utilization of developed oil resources means that once an oil pool has been found, all "recoverable" oil contained therein should be extracted. In the past, and to a very large extent at the present time, "recoverable oil" has a somewhat limited meaning. In the practice of many operators an oil sand, from which oil ceases to flow under its own power to the bottom of wells drilled into the sand from the surface, is considered to be "depleted." The fact generally is, however, that no oil reservoir ever gives up all its oil to the well by natural flow, and when the stage of free drainage, or "primary recovery" is ended, the operator has obtained hardly more than a third of the oil originally contained in the sand reservoir.

It is thus a fact that, generally speaking, for every barrel of oil that has been lifted to the surface, two barrels remain behind in the underground reservoirs. There are some exceptions as in the case of oil sands where a combination of ideal natural water drive and rational production practice may succeed in extracting up to perhaps 80 percent of the original oil content. Efficiently managed oil fields under a strong gas drive may also yield something better than a third of the original oil reserve. But ideal cases are few and far between, and the overall conclusion is still valid, namely, that the oil fields of the United States that have been discovered and produced by primary methods to the point of exhaustion since the time of Drake still contain a great deal more of oil than has been taken from them. For instance, the Bureau of Mines has estimated that in the known Appalachian low-pressure reservoirs, which have been exploited for 80 years, there remain 6,364,021,000 bbls. of Pennsylvania grade crude oil. Of this oil 929,856,000 bbls. are considered recoverable in part by gradually diminishing natural drainage, and in part by means of secondary methods of recovery now employed by petroleum engineers. If the above mentioned estimate of the Bureau of Mines is correct, after the petroleum engineers have done their utmost some 5,436,168,000 bbls. of this fine crude oil will have to be written off as inaccessible—unless some new principle or method is introduced into the art of secondary recovery applied to "depleted" oil sands.

It is not to be denied that in many cases an oil sand which has reached the final stage of natural drainage may be restored for a time to profitable production by an artificial water or gas (or air) drive; it has been and is still being done in Pennsylvania and elsewhere. But such cases have to be carefully selected and studied. The geological, lithological and physical circumstances of each case must be appropriate; and, in particular, unfavorable circumstances must be detected beforehand and guarded against. Even so, the record of secondary recovery projects can show a number of failures as well as striking successes. The number of failures is at least large enough to show that the method of secondary recovery by water and gas drives leaves something to be desired and that other principles should be sought. Some ten years ago (in 1933) some Russian petroleum technologists announced what they considered to be a new and promising principle of secondary recovery in depleted oil formations. Their idea, reduced to its simplest form, was



Sand Separator, Headframe and Shaft Building.

Drilling Machine for Horizontal Drilling.

to drill two wells into an abandoned oil sand a convenient distance apart. The bottom of one of the wells was to be charged with a sufficient quantity of wood charcoal, which was to be ignited electrically or otherwise from the surface. Combustion thus started would be supported by air from a surface compressor, and supplementary fuel could be added until the residual oil in the sand adjacent to the bottom of the red well was vigorously burning. Meanwhile the fire would be continually fanned by air from the surface. The oil sand, being sufficiently porous, with voids not completely filled with oil or water, would afford passage to the excess of air and the products of combustion, and the zone of combustion would spread through the sand along the line of least resistance, which would be in the direction of the other open well. Only a part of the residual oil would be consumed; the burning of this part would generate heat enough to volatalize and partly crack the other part; and these volatile products would be carried by the stream of mixed gas to the bottom of the "producing" well, whence they would be conveyed to the surface.

This idea was tried out experimentally. An artificial oil formation was prepared, consisting of a long 20-inch tube filled with fine sand wet with oil and tightly packed in to imitate a depleted oil formation. At one end, a vertical tube penetrated the sand from the outside to serve as the firing well, and at various distances other tubes represented producing wells. With this set-up the experimenters succeeded in expelling above 80 percent of the original oil content in liquid and gaseous form.

So far as this small-scale experiment goes, it is proven that combustion can be maintained in an enclosed sand body partly saturated with oil and free from water and that by burning a small part of the original residual oil the rest can be recovered as liquid and condensible products, plus a lean fuel gas. In principle at least, this procedure qualifies as a method of secondary recovery; its commercial practicality remains to be demonstrated. The Russians pursued the matter to the point of selecting an abandoned field in the Grosny district on which to give the idea a large-scale tryout, but no further reference to the project appears to be on record.

Recently there has appeared in the United States what is called a "thermal system for repressuring dead oil fields". The principle of this idea is to superheat air at the surface and to force this heated air to the bottom of an input well, where, after giving up most of its heat to the formation, it returns at a lower temperature to the surface for recirculation. When opposite the face of the depleted oil sand the injected air has a temperature of about 900° F. Pressure is gradually built up, and as a result of this pressure and the applied heat the residual oil is forced to migrate to producing wells in the vicinity, as in ordinary gas repressuring. This "thermal method" is, in fact, merely a process of repressuring with hot air. The use of heat is based mainly on the principle that warm oil has a lower viscosity than cold oil, and hence can pass more readily through the capillary spaces between the sand grains.

This idea has been tried out on two locations in Oklahoma. The first was on an old field with 30 wells averaging four bbl. of oil per day; after 10 days to two weeks all the wells on the quarter-section showed an increased flow of oil; the original temperature of this oil increased from 60° to 90° F. thus showing that the whole formation was feeling the effects of the added heat. After 40 days of more or less satisfactory operation the project went entirely to water. At the other location an input well was established in the center of a 5-well pattern, which produced large volumes of gas and some oil before an accident brought the enterprise to a stop. But it is now demonstrated that higher temperatures can be produced throughout an underground formation, and the operator can have whatever benefit there may be in a lower viscosity of the residual oil.

So far, the status of these thermal methods of secondary oil recovery is that, in principle, they have a certain soundness, but whether they can be turned to practical account remains to be seen.

Another method which seems to have more immediate prospects of wide use is an adaptation of mining methods, currently referred to in this country as horizontal drilling of oil wells. Instead of drilling a multiplicity of wells vertically from the surface into the underlying oil pool, a commodious shaft is sunk to the oil sand; the bottom of this shaft is widened to form a working chamber, from which horizontal holes are drilled into the sand in all directions to distances of 3000 or more feet.

The basic difference of this method of horizontal drilling as compared with vertical drilling may well be noted. The vertical hole can do no more than traverse the thickness of the oil sand and expose a relatively small free surface from which the oil may drain into the hole. Thus, a 6-inch hole in 20 ft. of sand will have 18.85 sq. ft. of exposed sand surface. A 3000-foot horizontal hole of the same diameter will expose 2835 sq. ft., that is to say, one 3000-foot horizontal hole will expose as much drainage surface in an oil sand as 140 vertical wells. Now, when the number of 3000-ft. horizontal holes is multiplied by 20 or more, all radiating out into the oil sand from the bottom of the shaft to all points of the compass, the amount of free drainage surface is enormously increased.

From the hydrodynamic standpoint, the increase of free drainage surface has this advantage: the average distance through which the oil in the sand has to travel to reach an open hole is shortened. The immediate result of the shortening of distance is that the sand can be more quickly drained, and the operation will pay out in a shorter time. From the hydrodynamic standpoint again, the recovery will be more complete. For example, it has been found that when an oil sand is produced from a number of vertical wells spaced some distance apart, the sand closest to the holes may be thoroughly drained, while farther back in the sand the final oil level stands higher. For this reason complete drain-

age requires a fairly close spacing of vertical wells. It costs a great deal to drill many vertical wells; therefore most operators seek the most economical balance between drilling expense and ultimate recovery.

The effectiveness of increased drainage surface on recovery is illustrated by the "oil mines" of Pechelbronn, where a heavy oil that has only a short radius of free flow is easily drained by a network of horizontal tunnels driven into the sand.

The widely used method of "shooting" a newly drilled oil well is a tacit recognition of the necessity of a large drainage surface. It often happens that when an oil-bearing formation is penetrated by the drill there is little or perhaps no flow of oil into the hole. This is especially the case where the sand is "tight" (having small permeability), or where the reservoir pressure is small. The remedy used in that case is to explode a charge of nitro-glycerine at the bottom of the well. The explosion shatters the sand and creates a large cavity from which radiate numerous cracks and crevices (in other words, a large drainage surface) through which the oil can now freely flow.

Another instance of a recognition of the need for greater drainage surface is an interesting experiment recently begun in the Midway Sunset area in California. Here an attempt is being made to create more drainage surface by making "windows" through the casing opposite a tight oil sand. By means of a special flexible joint a drill is introduced through the windows and a number of lateral holes are extended for some distance out into the sand. The experiment has not yet progressed very far, but the principle is evidently sound.

In passing, it may be noted that horizontal drilling has lately been employed on a considerable scale to increase the drainage surface and hence the capacity of water wells.

For the most thoroughgoing contemporary attempt to apply the principle of horizontal drilling to the production of petroleum we must turn to the work of Leo Ranney. His first experiment was made in the depleted First Cow Run Sandstone in Ohio. This sand has a thickness of about 20 feet, wherein the oil saturation was only about 15 percent (Fettke analysis) which is close to if not lower than what is considered necessary for actual flow in an ordinary drilled well; besides that, the rock pressure was only 20 ounces, and was too small to be of much help in imparting movement to the oil. In this project the sand was penetrated from the outcrop to some distance, where a working chamber was carved out. From this chamber six 3-inch holes were drilled radially and horizontally into the sand for considerable distances.

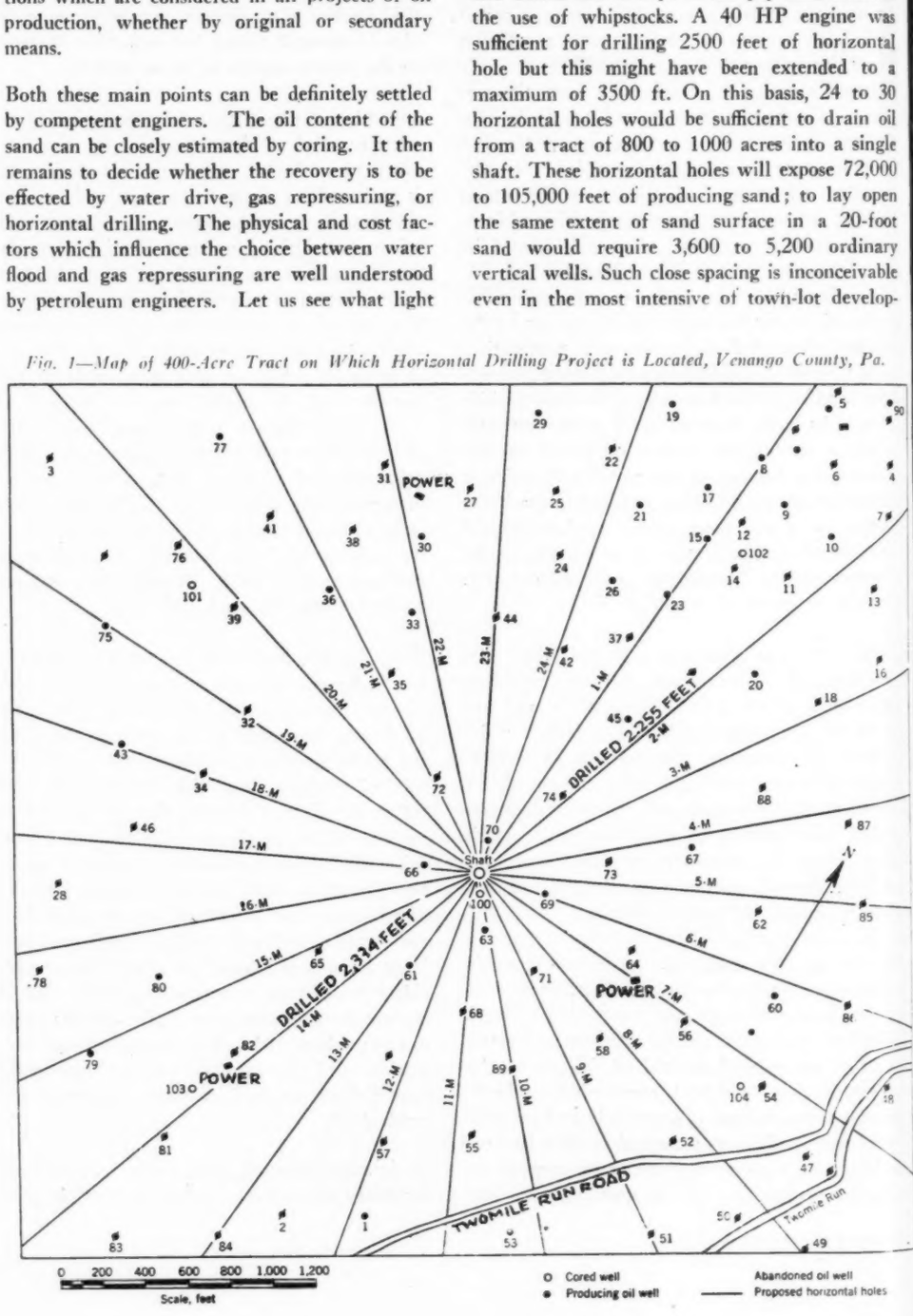
Ranney's Ohio project has been described at length by various writers. The present writer's purpose is to appraise what it has done to establish horizontal drilling as an actual or potential addition to presently known methods of secondary recovery. In making this appraisal the question of whether the method can be profitably applied to any or all cases is left to one side, to be settled by an on-the-spot engineering evaluation of all the pertinent factors affecting individual projects.

The petroleum engineer who is called on to evaluate a project of this kind will need to consider two main points. The first point is whether the property which is underlain by the depleted sand contains enough oil to warrant recovery. The second point is whether the cost of sinking a shaft, and drilling and operating the horizontal wells, will be more than recovered by the value of the oil obtained. These are practical questions which are considered in all projects of oil production, whether by original or secondary means.

Both these main points can be definitely settled by competent engineers. The oil content of the sand can be closely estimated by coring. It then remains to decide whether the recovery is to be effected by water drive, gas repressuring, or horizontal drilling. The physical and cost factors which influence the choice between water flood and gas repressuring are well understood by petroleum engineers. Let us see what light Ranney has thrown on the controlling elements in horizontal drilling. The cost of sinking the shaft can be regarded as fully known.

Given a drilling log of a well where the shaft is to be sunk, any local contractor will be able to submit a turnkey bid. There is then the question of the cost of drilling the horizontal holes radiating from the bottom of the shaft. At the Cow Run project Ranney drilled 7500 feet of horizontal 3-inch hole, at rates of 55 to more than 100 feet per 7-hour shift, which he says is a reduction of 75 percent from the usual drilling time in deep wells. His drilling costs, including preliminary experimenting, are given as 90 cents per linear foot. The direction of the horizontal drill is under as complete control as in vertical drilling. The stratum of oil sand may be undulating; the drill follows the ups and downs and is kept in the pay sand without the use of whipstocks. A 40 HP engine was sufficient for drilling 2500 feet of horizontal hole but this might have been extended to a maximum of 3500 ft. On this basis, 24 to 30 horizontal holes would be sufficient to drain oil from a tract of 800 to 1000 acres into a single shaft. These horizontal holes will expose 72,000 to 105,000 feet of producing sand; to lay open the same extent of sand surface in a 20-foot sand would require 3,600 to 5,200 ordinary vertical wells. Such close spacing is inconceivable even in the most intensive of town-lot develop-

Fig. 1—Map of 400-Acre Tract on Which Horizontal Drilling Project is Located, Venango County, Pa.



ments. It is thus certain that the average distance through which the oil flows to reach a drain is vastly reduced, which partly explains why a "depleted" oil sand with a saturation of only 15 percent can be drained of more of its oil.

Another fact established at the Cow Run project is that horizontal holes can be shot with nitroglycerine more effectively than in vertical holes, because more explosive in a longer string can be used. At least that is Ranney's conclusion. In a vertical hole the effect of the explosion is mostly lateral, and is thus parallel to the planes of sedimentation, whereas in a horizontal hole, especially if the hole is in the lower half of the oil stratum, the force of the explosion is exerted both laterally and vertically. The result is an extensive shattering and cracking that has been found to extend for 40 feet on both sides of the long hole. This loosening of the whole structure of the sand body tends to destroy tight streaks and pockets that would be bypassed by a water drive or an artificial gas drive, and which in many secondary recovery projects retain much oil that should otherwise be recoverable.

The Cow Run project seems to have proved that in two major respects the drilling of horizontal holes in depleted oil sands is a definite contribution to the art of secondary recovery. In the first place, the cost of a project can be estimated within narrow limits. The chief item of expense is the central shaft, the sinking of which is a routine contracting matter. Drilling the horizontal holes is a relatively simple matter, as the bit is always in the porous oil sand, and the driller does not have to contend with heaving shales or other common hazards of drilling for oil. For these reasons, Ranney's claim that drilling costs are reduced by three-fourths may well be allowed provisionally. The other decisive point that seems to be established in favor of horizontal drilling is that it is possible to open or loosen up practically the whole sand body under an extensive tract, and thus provide conditions for draining oil that otherwise would not move under the force of gravity.

Of course, horizontal drilling cannot be indiscriminately applied to any or all depleted oil sands; like all the other methods, its use must be dictated by the results of a previous engineering examination of the situation, in which full weight must be given to the prevailing economic conditions. The chief limit on the method will be the depth to which it is possible to sink the shaft; 3000 feet is thought to be practicable, and possibly this might be extended. The 3000-ft. range will include very many old oil fields, which are particularly numerous in the Appalachian region.

At any rate, the results obtained in the Cow Run sand have inspired a project sponsored by 13 oil companies and refineries and other private interests to undertake a more ambitious project on a 400-acre tract in the Franklin heavy oil field in Sugar Creek Township, Venango County, Pa. The oil-bearing sand lies at depths within 317 to 770 feet from the surface; core analyses indicate an average oil saturation of around 25 percent and a total oil content of around 7,000 bbl. per acre.

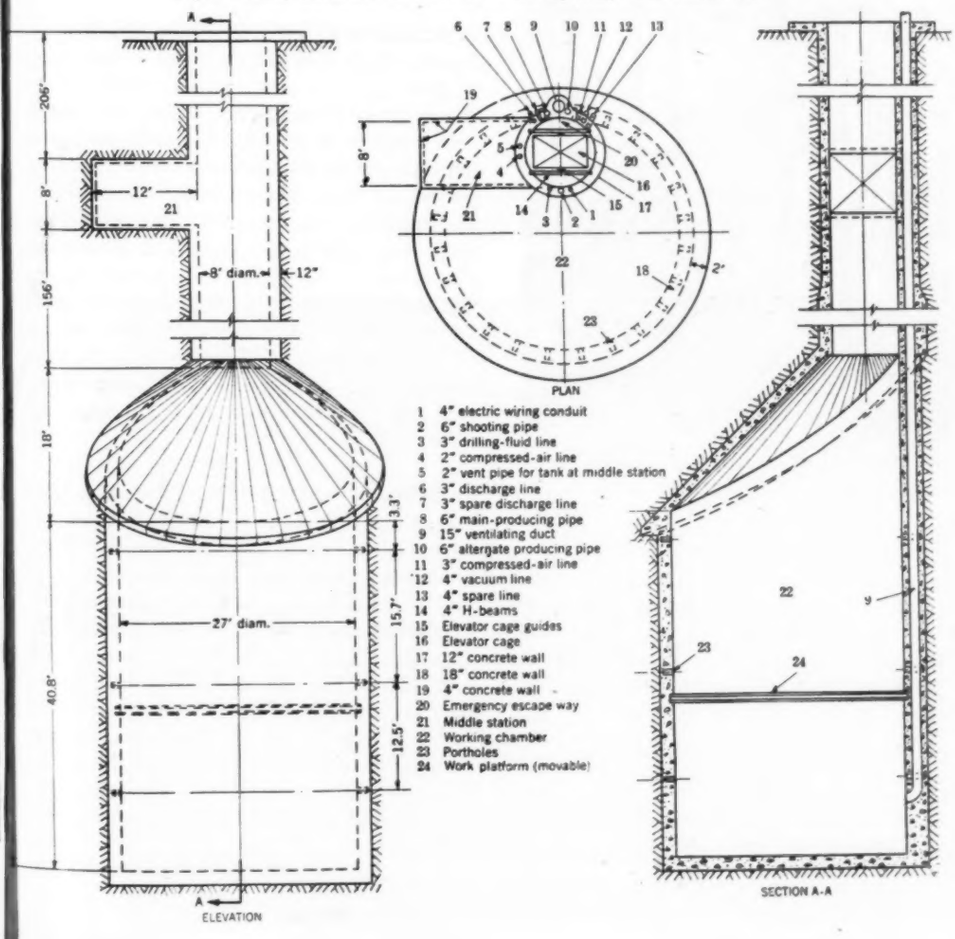
The plan of the project is indicated by the accompanying diagram, Fig. 1. At the center of the tract a 428-ft. shaft has been sunk through the oil sand. From the bottom of this shaft it is proposed to drive 24 horizontal holes radiating in all directions. Two of these holes were already completed during the past summer to distances of 2255 and 2334 feet.

As shown in vertical section, Fig. 2, the upper part of the shaft has a diameter of eight feet and is lined with concrete. At a depth of 370 feet the shaft is enlarged to a concrete-lined work chamber 27 feet in diameter to provide space for horizontal drilling operations, and for oil and water pumps. Midway between the working chamber and the surface is an 8 x 12 x 8′′ rectangular "middle chamber", to be used as an intermediate stop or landing stage in certain operations between the bottom of the shaft and the surface.

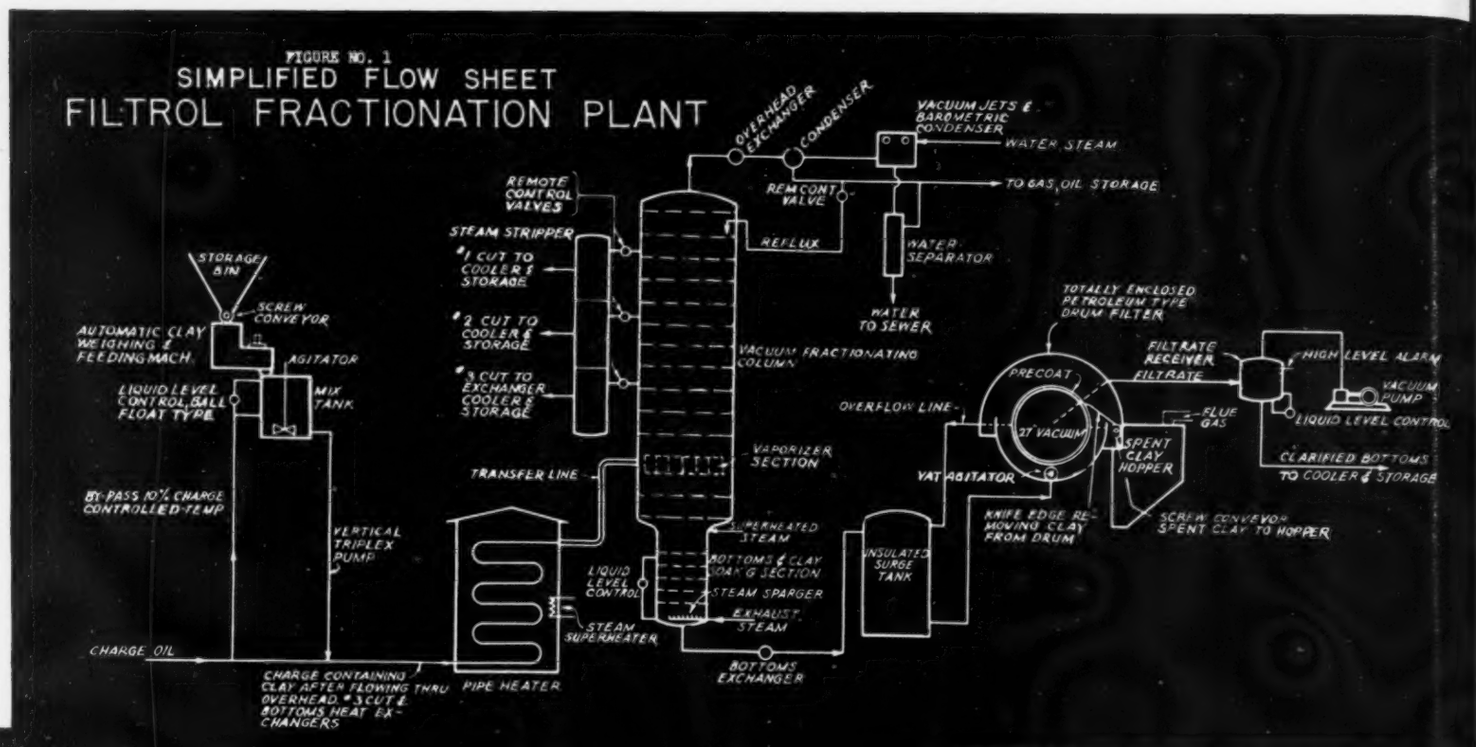
The surface and subsurface equipment of the shaft, methods of drilling and other details are fully described in a bulletin of the Bureau of Mines* and need not be repeated here. The horizontal holes were drilled with a rotary drilling machine which is arranged in such a manner that holes can be drilled in diametrically opposite directions without changing the position of the machine. At first diamond core bits were used for drilling; diamond consumption was high, but later on it was found possible to make effective use of rock bits. The two holes so far drilled are shown in the diagram of Fig. 2 as 2-M and 14 M. Minor incidents occurred during the drilling of these holes, due chiefly to variations in the horizontal composition of the oil sand, from tight and hard to soft and loose-sandy. No difficulty was encountered in changing the vertical direction of the bit to follow the undulations of the oil sand.

As the project is still under development no comprehensive figures have been released as to either costs or production. As regards costs, it does not, so far, appear that the plan as outlined will cost more than a comparable plan for a water flood project on the same tract. As to production, preliminary experience has raised expectations of an average initial flow of one-sixteenth of a barrel of oil per linear foot of hole per day. If this expectation is realized the horizontal-drilling method will have established itself as an approved method of secondary recovery, applicable to any suitable shallow depleted and relatively water-free oil sand that still contains enough oil to be worth while.

Fig. 2—Plan, Elevation and Section View of Shaft and Chambers.



Horizontal Drilling for Oil in Pennsylvania by C. W. Elder, Jr., Report of Investigations No. 3779, Bureau of Mines, 1944.



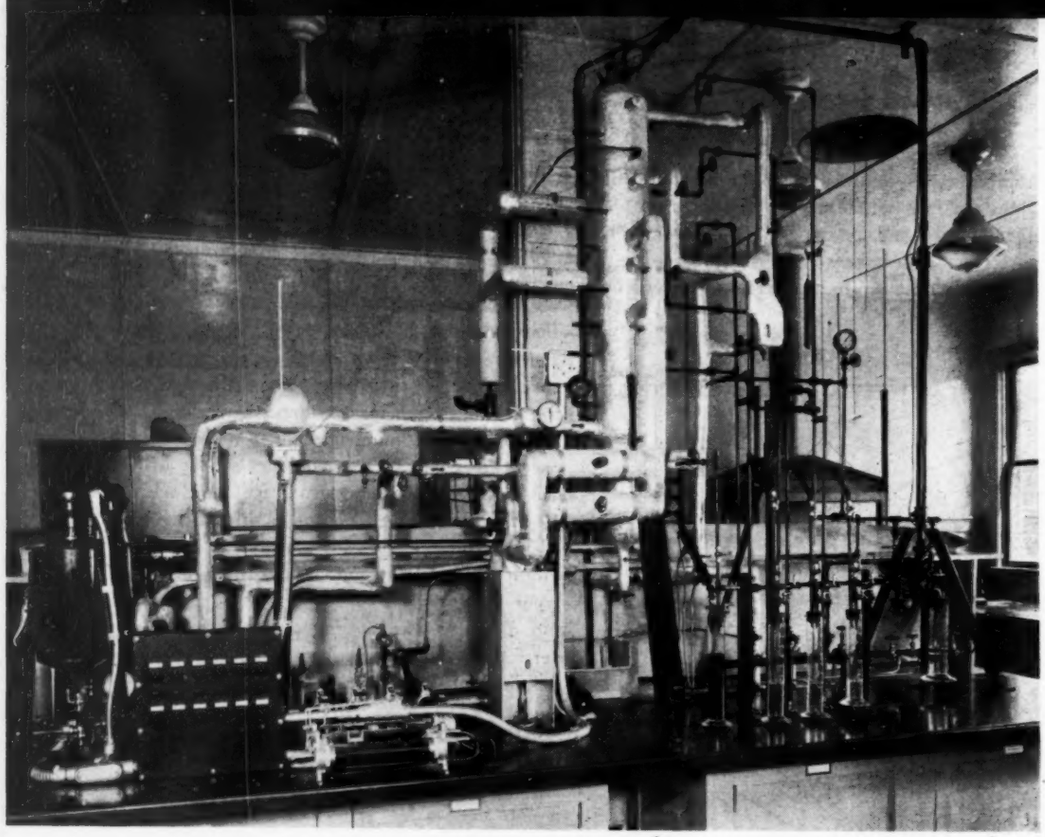


Fig. 4—Filtrol's Pilot Plant Unit.

Filtrol Fractionation

By Walter Kitchens

Filtrol Corporation

THE production problem of supplying large quantities of lubricating oil to meet military demands during the war has brought about the development of new refining techniques producing high quality lubricating oil from inferior crudes. Filtrol fractionation has played a large part in making possible the mass production of high quality finished oils from low grade lube stocks. If the war should continue for several years, additional supplies of lubricating oil will be required. In the event of an early peace, the same high quality lubricating oil will be needed for civilian use. It therefore seems appropriate to present information on Filtrol Fractionation, a process licensed by Filtrol Corporation for the finishing of lubricating oil.

The name, Filtrol Fractionation, given to the process of combining distillation and adsorption is appropriate. Filtrol is synonymous to purification by selective adsorption and Fractionation deals with the separation of the many oil hydrocarbons into groups, according to their boiling point characteristics. These two operations combine to give optimum adsorbent performance during the vacuum separation of neutrol stocks from bright stocks. In addition the undesirable oxidation occurring when lube stocks are cooled after distillation is held at a minimum if Filtrol has been present during the heating period to adsorb and remove from the oil those compounds which would act as oxidation accelerators. The removal of these unstable molecules prevents their polymerizing with other molecules present to form tars and resins.

In its basic aspects, a Filtrol Fractionation unit consists of a heater, a vacuum fractionation tower, a surge tank, a rotary pre-coat filter, preheaters, clay feeding equipment, slurry mixing devices, and the pumps and tanks necessary for efficient moving of the oil and clay through the unit. Figure No. 1 illustrates a simplified flow sheet of this operation. The heater may be of any conventional design and of a capacity that will vaporize up to 75 percent of the charge at the vacuum to be used in the tower. With an efficient system of heat exchangers, the oil-Filtrol slurry should enter the furnace

at about 350°F. and flash into the fractionation tower at about 650°F. As the oil charge enters the tower it is diluted with superheated steam and the vaporized portion is carried up the tower, which is equipped with ordinary plate and bubble cap arrangements. With this system, the neutral oils are subject to adsorbent purification in the heater, but as they are flashed into the tower, the total clay charge remains in the bright stock portion where it is held at a lower temperature for a predetermined soaking period. This procedure provides the desired amount of adsorbent purification for the bright stock.

The high adsorbent efficiency of Filtrol under these conditions is reflected in neutral stock colors of 1¼ N.P.A. and bright stock colors of 4½ N.P.A. with Filtrol dosages of as low as two pounds per barrel lube stock, depending, of course, upon the stock being processed. The neutral oils, or side-streams Nos. 1, 2, and 3 are taken off, as shown in Figure No. 1, and pumped directly, without further processing to finished oil storage tanks. These side-streams represent from 50 to 75 percent of the total charge, depending upon the type of operation ordered. The residuum is drawn off the bottom of the tower and into a surge, or filter feed, tank where additional soaking time for the purification of the bright stock cut is obtained. The oil passes from the surge tank to the rotary precoat filter tub at a controlled rate to maintain a given level in the surge tank. The oil is filtered at a temperature of 350° to 400°F. and transferred into a filtrate receiving tank through coolers and then to storage. The spent Filtrol is removed from the filtering drum to the spent clay bin by automatic devices.

In addition the unit may be used for continuous contacting if the desired operation is to finish a short residuum stock or refined wax. Figure No. 3 shows the tower temperatures and product distribution occurring when the Filtrol Fractionation unit is used for a straight contacting operation.

The operation of a Filtrol Fractionation unit is excedingly flexible and may be used on a wide variety of charging stocks, with equally satisfactory results. The plant may be readily adapted also to the finishing of products differing widely in physical properties. A long residuum may be separated into several neutral oils with bright stock bottoms and a short residuum, refined wax or insulating oil may all be contacted in the same unit with a rotation of operation schedules. The small quantity of oil actually in the treating system at one time allows for a quick change-over to other products, with a minimum of contamination. Further flexibility may also be obtained by changing the quantity of adsorbent used, which in turn will give light or dark colored bright stocks. Oils of almost any desired viscosity may be obtained in continued operation by changing the ratio of oil taken from the three side-streams.

For the most part pilot plant studies by Filtrol Corporation Research Division have been confined to checking optimum temperatures, clay dosage required, and contact time for individual samples of a wide variety of lubricating oil stocks. Much work has also been done in connection with improving the quality of Super Filtrol for more efficient application in this processing. Figure No. 4 depicts Filtrol's pilot plant unit. Excellent correlation has been obtained between pilot and commercial plant data. However, in comparison to pilot plant operation, it has been noted that smaller dosages of Filtrol per barrel of oil are needed and a somewhat higher quality oil, as judged by engine tests is obtained on the oil finished in the commercial units.

For discussion, the advantages of Filtrol Fractionation may be centered around processing a high quality lubricating oil at lower cost. Just as contact filtration reduced the cost of processing from the older type filter finishing through a saving of labor and equipment, Filtrol Fractionation combines distillation with the contact filtration step for a number of further savings in equipment and labor. In modern plants it is possible to operate a unit having 1500-3000 barrels per day output with only two men per shift. Low clay consumption, with the resultant saving in labor involved for handling materials, together with process simplicity, and modern automatic control devices, reduces labor costs to a minimum. While the adsorbent constitutes the greatest part of the total cost for finishing an oil by this process, adsorption under these optimum conditions is such that minimum quantities of Filtrol per barrel of charge stock are necessary for neutralizing, stabilizing, and decolorizing most solvent treated oils. The low dosage of Filtrol required, combined with the dry filter cake obtained by using a rotary precoat type filter tends to hold oil losses, due to oil retention in the press cake, to negligible proportions.

Selective refining accomplished through the use of Filtrol Fractionation is especially desirable in finishing oils to be blended with additives, in that insoluble sludge-forming compounds and certain other compounds that reduce the effectiveness of additives are absorbed. Thus, when artificial additives are blended with Filtrol Fractionated stocks, an oil is produced that is highly resistant to the formation of soluble or insoluble sludges. In connection with this and as additional proof of the high quality of oil finished in this manner, the entire production from existing Filtrol Fractionation plants is at present being taken by the armed forces and is meeting all the tests required by United States Army-Navy specifications. The larger portion of these stocks is blended with additives for use as heavy duty motor oils. However, some 1120 aviation grade motor oil is being processed in these units.

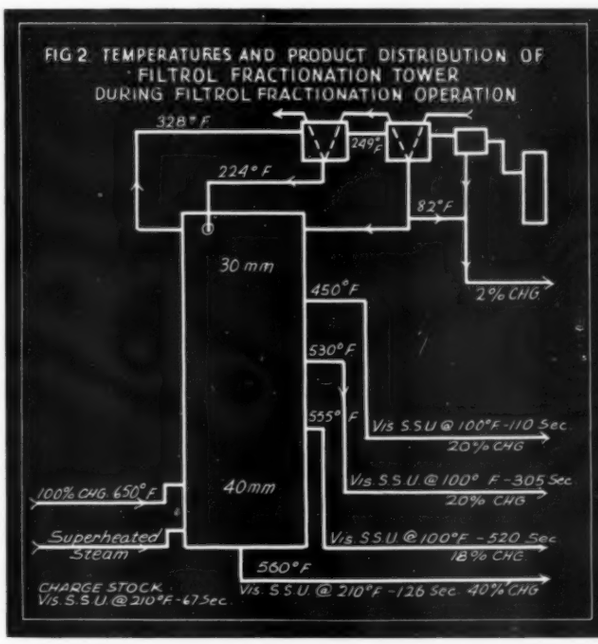


FIG 2. TEMPERATURES AND PRODUCT DISTRIBUTION OF FILTROL FRACTIONATION TOWER DURING FILTROL FRACTIONATION OPERATION

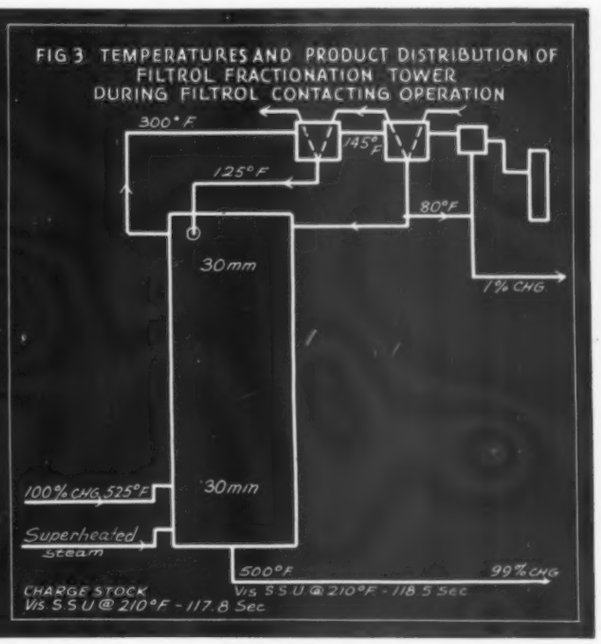
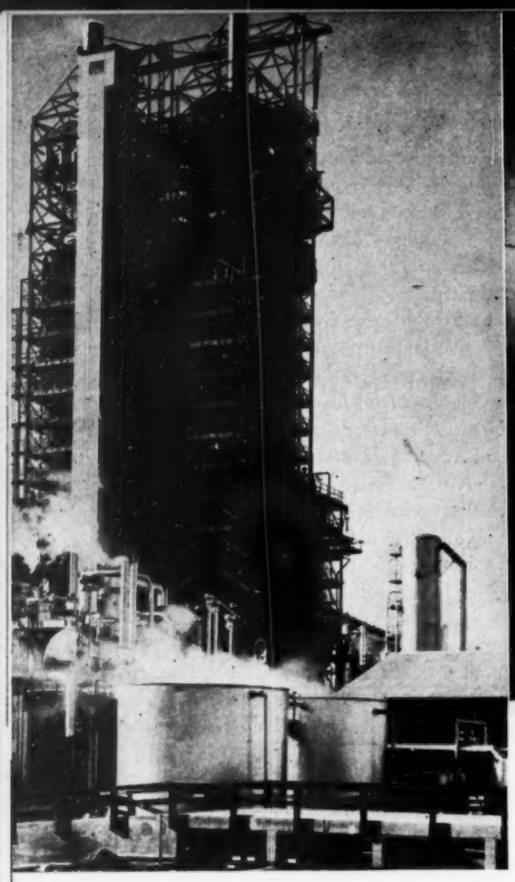
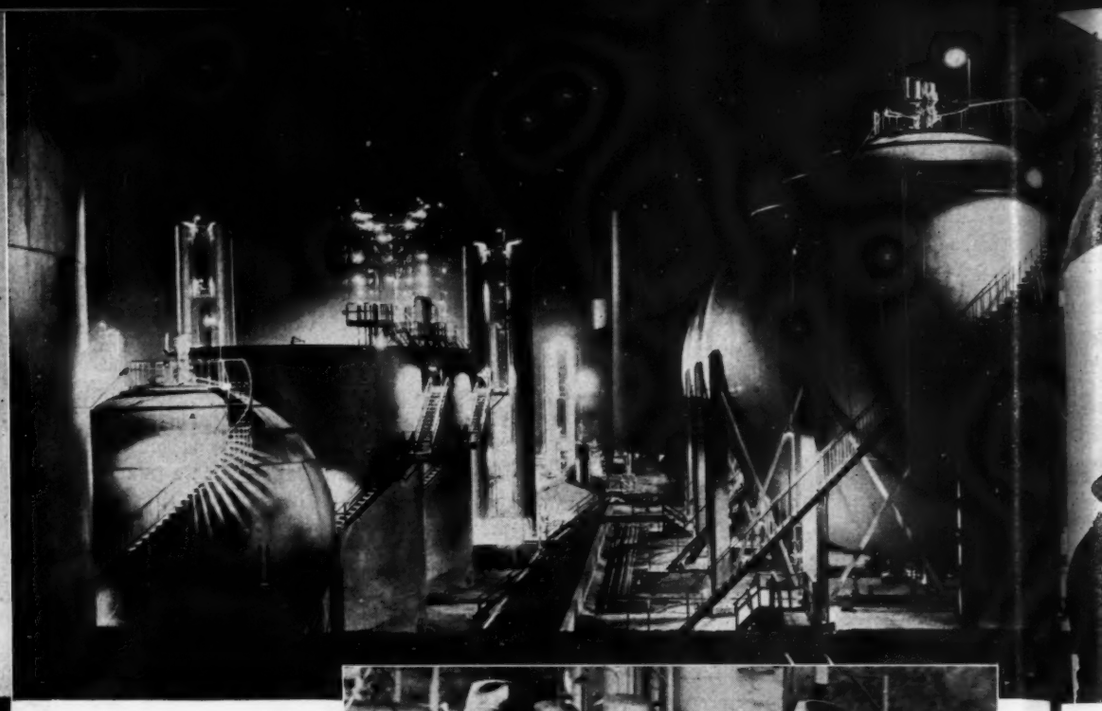


FIG 3. TEMPERATURES AND PRODUCT DISTRIBUTION OF FILTROL FRACTIONATION TOWER DURING FILTROL CONTACTING OPERATION





Above: 100-Octane Storage Tanks.

Left: T.C.C. Unit, Power Plant in Foreground.

Left to Right: Capt. T. W. Peters, Acting Marine Superintendent at Richmond; Capt. Lawrence Wolff, U. S. N. Officer in Charge, Petroleum Pool, Pacific Coast; R. K. Rowell, Manager—Guests at Richmond's Dedication Ceremonies.

CALIFORNIA STANDARD ADDS NEW

100-Octane Unit to Great Richmond Plant

AS a result of the speeding up of contruction during the final months of 1944 the new 100-octane gasoline unit of Standard Oil Company of California at Richmond, California, was completed and ready for operation at the beginning of January. It was formally dedicated on January 16. This new installation which is operated by California Standard for Defense Plant Corporation was erected at a cost of $20,000,000 and its addition to facilities previously existing places Richmond among the world's largest plants producing gasoline of 100-octane or higher.

The new unit employs the Thermofor Catalytic Cracking process and its central feature is the lofty cracking tower which rises 238 feet in air, about the height of a 22-story building. Other distinctive structures in the group of war service units are the recovery towers, 17 feet in diameter and 88 feet high, the isomerization plant, the butane-pentane distillation unit, the H. F. alkylation unit and the power plant. Fifty cars of catalyst beads, some 1,600 tons were required to load the plant for starting and some mathematical expert connected with the company has figured out that these 50,000,000, more or less, beads, if strung, out in a necklace would reach three times around the globe. One of the innovations included in the plant because of its height is a passenger elevator for use of the working force.

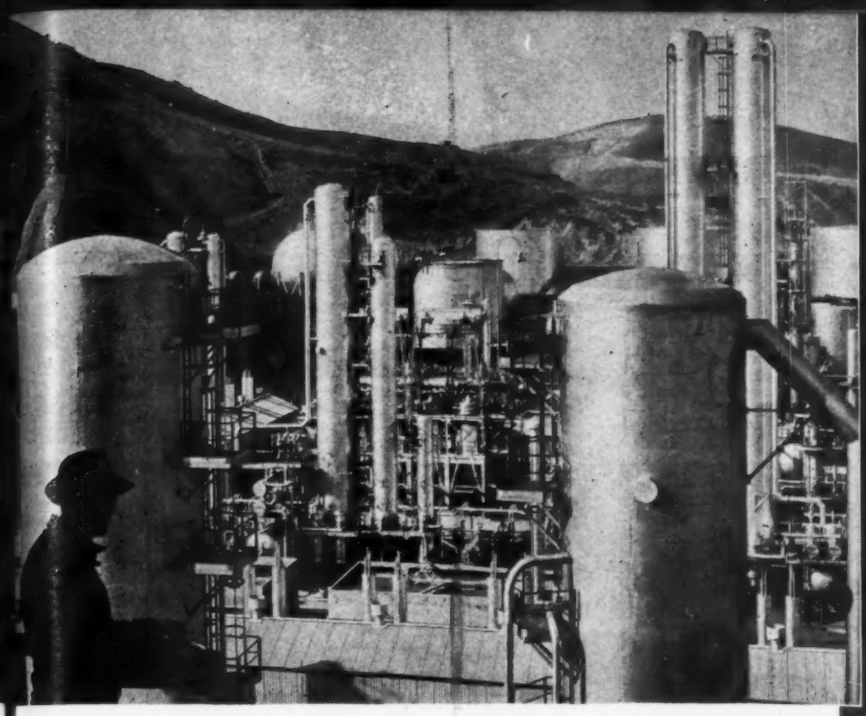
Direct access to tanker loading facilities gives the new plant high strategic value. In addition, refinery barrel loading facilities have been expanded so that a large portion of the output can be transported in easily handled metal drums.

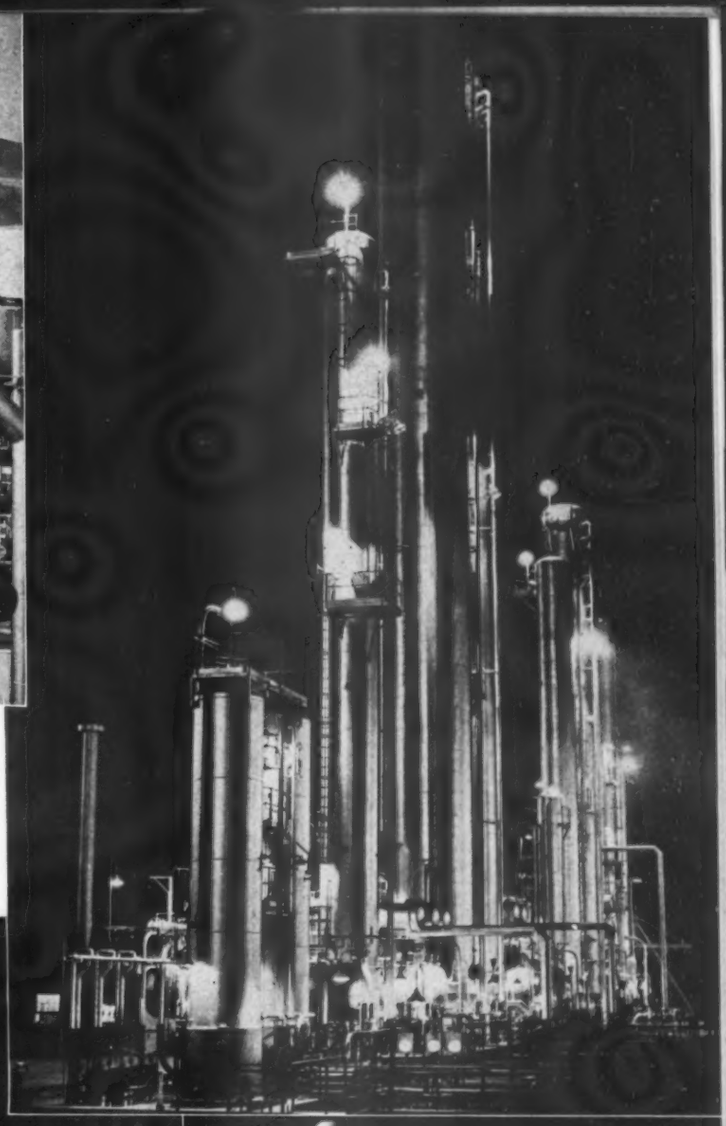
The big "cat cracker" houses a maze of furnaces, kilns, piping and motor operated valves. There are two units, one of which cracks lower grade petroleum products while the other upgrades the gasoline produced in the first operation by subjecting it again to the action of the catalyst. Out of this double treatment comes a stock which is blended with other stocks to make the product that finally goes into the bomber's gasoline tanks.

While the products that flow into these units are spoken of as "lower grade" or "middle of the barrel" fractions of crude, actually they would have been considered "top grade" prior to the war. They are 91-octane gasoline, automobile grade gasoline, burner oil and butane. Although the identical process is not used in this operation, cracking methods now are so advanced that 100-octane could be made out of asphalt oil if necessary.

Products to be cracked are vaporized in a furnace and then fed to a reactor vessel which in this case happens to be a 50-foot tube 18 feet in diameter. It is filled with catalyst which flows downward. The vapor flows upward and in passing through the catalyst deposits carbon in the beads. At the bottom, live steam is shot across under such pressure that it makes almost a solid sheet to retain the vaporized petroleum in the reactor while the catalyst beads, now carbon impregnated, flow out, like rice from the bottom of a bin.

These beads are caught in an elevator, of the endless-chain bucket type, and hoisted to the top of the thermofor kiln into which it is dumped. Air is blasted into the kiln to burn the carbon deposited in the beads, thus restoring the activity of the catalyst. The cleaned catalyst is recaptured at the bottom and then conveyed again 200 feet to the top of the reaction vessel for re-use. Each of the four catalyst elevators has a capacity of 150 tons an hour of the catalyst and operates in temperatures up to 900 degrees F. The two kilns in the cat crackers each can burn more than four tons of carbon





Above: View of 100-Octane Plant from T.C.C. Tower.

Right: H. F. Alkylation Plant.

Below: Isomerization Unit.

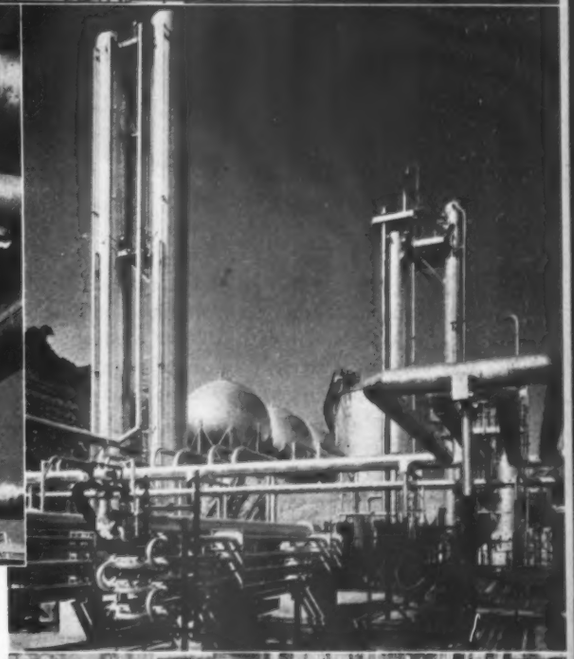
off the catalyst each hour — an amount which further indicates the tremendous quantities of materials handled. Even the heat generated by the burning carbon is not wasted. It is used to generate high pressure steam to supply, in part, the steam requirements of the other units of the plant.

There are three other major processes in the plant:

(1) The butane isomerization unit converts normal butane into isobutane, a required component for production of alkylate, the basic high octane blending agent. This unit employs the design developed by Standard of California.
(2) The hydrofluoric acid alkylation unit takes isobutane and other light hydrocarbon fractions and synthesizes them into alkylate. Virtually all the recoverable aklylation feed stocks produced in the entire Richmond refinery now are converted to high octane alkylate, which accounts for the large quantity of 100 octane produced from each barrel of crude. Handling the acid requires extreme care and only men clothed in special rubberized suits and masks are allowed in the area.
(3) Distillation equipment for rejection of normal pentane, permits removal of low octane normal pentane from base stocks to upgrade them for subsequent use in 100 octane blending.

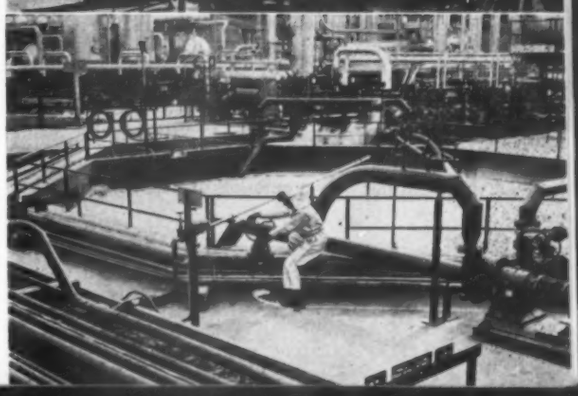
Two large furnaces are used to heat the oil fed to the reaction vessels. Each contains two fireboxes and each of these is 36 feet square and 16 feet high. Each furnace burns enough fuel in an hour, to heat an ordinary seven-room house for a year.

Standard is operating the 100 octane plant under lease agreement with Defense Plant Corporation. Construction was sponsored by the Petroleum Administration for War with DPC funds.



Right: Butane-Pentane Distillation Unit and Storage Tanks.

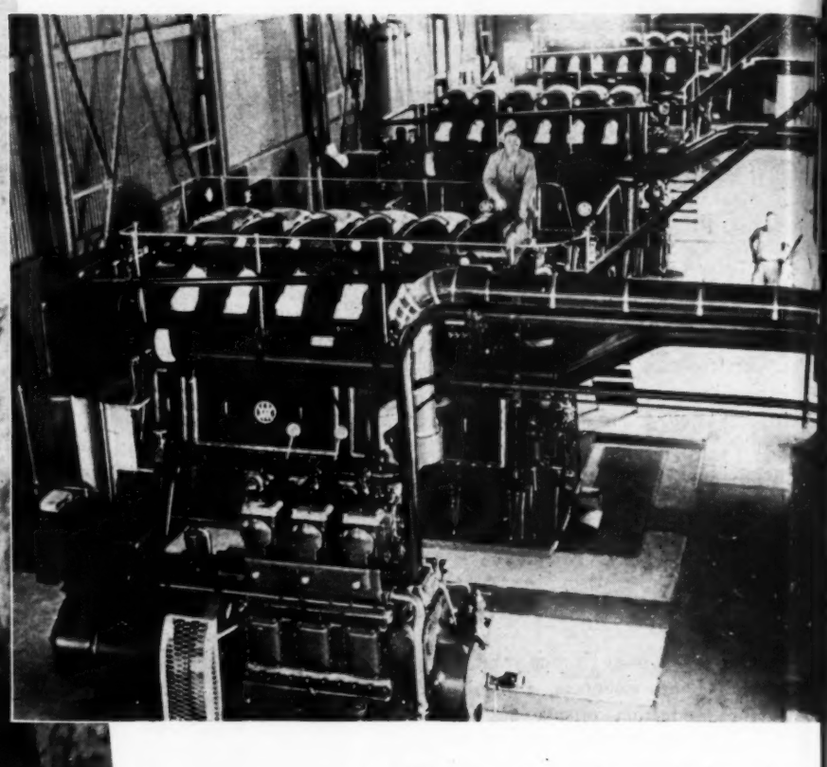
Equipment process designing with the exception of the catalytic cracker, was by the California Research Corporation, a subsidiary of Standard. The catalytic cracker was designed by the Bechtel-McCone Corporation, which engineered and constructed the plant.



H. F. Alkylation Neutralization Plant.

BRITAIN'S PIPE LINE SYSTEM TRANSPORTS OIL PRODUCTS FOR WAR USE

Laying Pipe Line Through the English Countryside.



Diesel Engines Drive Pipe Line Pumps.

FOR the first time in its history the United Kingdom now has an extensive pipe line system for the distribution of petroleum products. It was begun in 1941 as part of the provision for a great Allied offensive against Nazi forces on the Continent. It has been expanded at frequent intervals since that time as the strength and scope of this offensive has grown. Primarily, intended to serve the hundreds of airfields that have been established in Great Britain, the system has attained a length of a thousand miles by the first of this year when Geoffrey Lloyd, Parliamentary Secretary of the Ministry of Fuel and Power, made public an account of the undertaking which previously had been kept secret for reasons of military security.

"To meet the needs of the Allied forces", Mr. Lloyd's statement explained, "Britain has had to be made into a great military oil dump. It has been not only a question of importing petroleum in quantities never previously approached or imagined. Once here, oil must be rapidly discharged, distributed and stored. Since 1941, we have constructed in Britain an elaborate, inter-connecting pipe line system a thousand miles long, and studded with scores of secret underground storage tanks, capable of holding large reserve stocks. It is a wholly British achievement in conception, planning and execution; the work of British engineers, employing British-made material and British labor throughout.

"Already, no less than 2,400,000,000 gallons of oil, including hundreds of millions of gallons of aviation spirit, have been carried to the principal centers of consumption, especially airfields. Without pipe lines, the build-up of the Allied air offensive to anything like the desired scale would have been impracticable, and the problem of providing the huge petrol needs of the Allied invasion armies would have been greatly complicated.

"The work on the pipe lines has gone on with great cheerfulness day and night all the year round, often in bitter weather and in waterlogged ground. Every difficulty was overcome because of the pressing military need, and every branch of the line has been completed on time and in many instances before schedule."

During recent months 5,000,000 gallons (roundly 120,000 bbl.) of petroleum products were carried daily. The pipe line cost about £7,000,000 ($28,000,000) and 80,000 tons of steel were used in the construction. One reason for its construction was the great increase in the quantity of oil that had to be transported to supply the Eighth and Ninth Air Forces of the United States which have carried out their bombing attacks on enemy objectives from British bases. It has also facilitated the delivery of over 383,050 liquid tons of petroleum products which the British War Office handed over to the United States Ground Forces, under reverse lend-lease, between January 1 and June 30, 1944. It is reasonable to suppose that at

Pipe Line Spanning a Stream.

least 50 percent of these quantities went into the operational stock pile accumulated for the invasion of France.

Although the ever-growing needs of the R.A.F. were in mind, the first part of the network to be laid down was a line to link southwest ports with the London areas. This pipeline was intended for aviation spirit, but it helped the situation by leaving the British railways free to carry the increasing quantities of aviation spirit needed by RAF Bomber, Fighter and Coastal Commands. The terminal depot opened on December 5, 1941, six months after the preliminary work on the line had been begun. The next section of the plan was the linking in of the oil ports of the northwest coast, and this was achieved by a pipe line from this area running southwards to join the first line.

Facilities for pumping in either direction were provided and storage depots were linked into the pipe line. In the event of damage to west coast oil terminals, supplies, with an additional line, were available and could be pumped from the north or south, and the eastern area was thus provided with two sources of supply. This second line began operation on May 30, 1942.

For the needs of D-Day, the next move was to make these new facilities available by linking in what were to become invasion bases. In the early summer of 1942, a spur from the original line was run to the south coast. Forty miles of the line, started May first, began operating June 30. Up to this point, the system had enabled the British railways to deal with the rapidly growing demand by the RAF for aviation spirit, by relieving them of carriage from west to east of tens of millions of gallons of gasoline and paraffin. But further pipe lines were needed to handle the enormous increases in aviation spirit requirements of the RAF and British-based United States Air Forces. A big bomber offensive was beginning, and to prevent a lack of the high-octane fuel needed to sustain this offensive, the British Oil Control Board decided upon a new series of pipe lines to carry the aviation spirit from west coast ports to depots within easy reach of the great new airfields, already built or then building in large numbers.

The plan provided for lines running from the west coast ports handling incoming tankers. These lines linked up to form an aviation spirit circuit over 350 miles in length. In building this circuit, all types of country were encountered, and one stage of the line crosses terrain well over 1000 feet above sea level. Work on the circuit started on October 1, 1942, both lines from the western ports began operating in March and the circuit was completed by the end of August 1943. A considerable number of important storage depots were linked into the circuit and it is now the life line of the air arm stretched from the British Isles to pound the Reich.

In the autumn and winter of 1943, further extensions to the pipe line system in the south and east of England were undertaken, partly to meet special Air Force needs and partly for the continental requirements of the Allied armies. The shortest of these extension lines runs for 22 miles and the longest for about 120. Another is nearly 100 miles in length, and all were in operation by the middle of March, 1944.

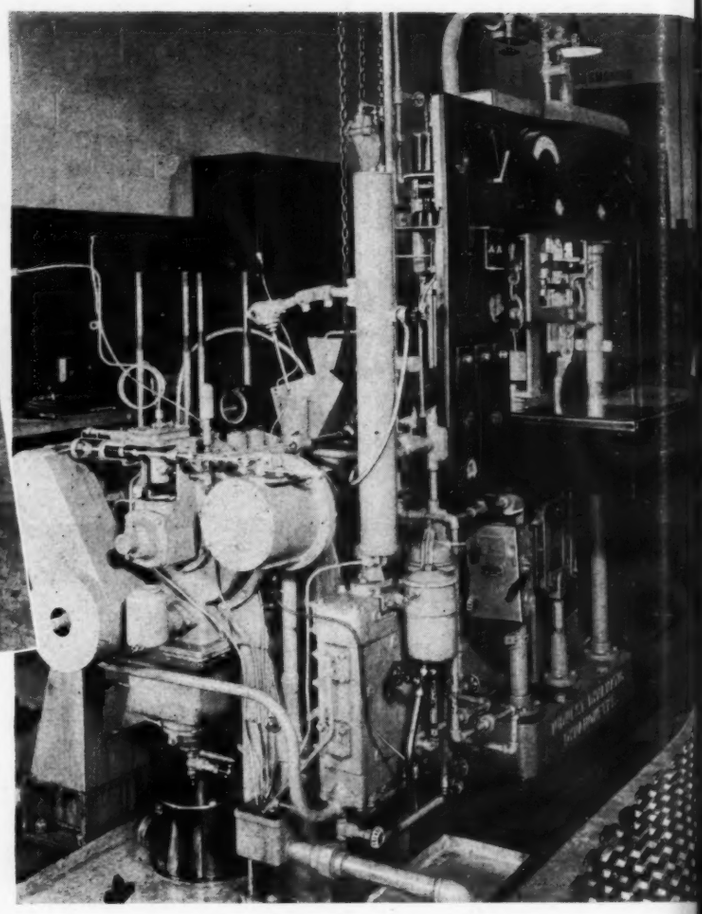
The method of organization worked out for the original pipe line was so successful, that it was used in the construction of all succeeding lines. The route to be covered was broken up into a number of sections with a view to carrying on the work at equal speed in all sections, with completion to be reached simultaneously. Each section was a self-contained unit with its own engineers, lands officer, labor force and mechanical equipment. The allocation of materials as they became available and the delivery of the pipe to each section proved the most critical job. On this depended the equal progress of every part of the line throughout. Speed was the keynote, but quality of materials and workmanship were of paramount importance, oil being the most searching of liquids.

Routes were chosen across open country wherever possible so that the fullest use might be made of mechanical excavators. Agricultural interests were closely watched. On an average, a strip of ground 15 to 20 feet wide only was taken for the right of way and this was out of use only for a comparatively short time. In trenching, the top soil was removed and kept separate from the sub-soil so that on completion the top soil was again replaced on top of the trench, and farming could continue uninterrupted as soon as the laying of the line was completed.

Many physical difficulties were encountered including rivers by the score to be crossed, ranging in size from large tidal estuaries and middle reaches of substantial rivers, to small brooks and drainage ditches a few feet wide. With the enormous demand for steel for all war purposes the speed of laying was limited by deliveries of pipe from the mills. The maximum laid in one week was eighteen miles of ten-inch line. The best sustained effort was one hundred and twenty-five miles of both ten-inch and eight-inch, in eighty-four days. More than half the system consists of eight-inch pipe and more than a quarter of ten-inch. The short stretches of spurs consist of twelve-eight or four-inch pipe. Practically all the lines are designed to work at a pressure of six hundred pounds per square inch. This pressure enabled comparatively light steel pipe to be used, and thus large quantities of steel were saved.

In normal construction, every joint in the pipeline is butt welded. The lines had to be built without welders, as none could be spared from the shipyards. In place of welded joints, special couplings are used. These allow a certain amount of expansion in length in the line. Where only welded joints could stand the strain of pressure, anchors are used—small concrete piers through which a line runs at points where it bends, and relieves the joints of all abnormal strain. The pumps used are nearly all of the centrifugal type driven by electric motors. To maintain efficiency and prevent the formation of rust, scrapers and brushes run through the lines at regular intervals. Before it was used by oil, the pipe lines were tested with water at considerably over working pressure, and "go-devils" were sent along the entire length. The whole system is under a continuous patrol and this constant inspection ensures a never ceasing flow through the great pipe line system of oil transportation across Britain.

Dynamometer Room Used for Diesel Engine Testing.



Diesel Engine Setup With Panel Board.

SUN'S NEW AUTOMOTIVE RESEARCH LABORATORY

By Dr. O. W. Willcox

ON February 9 of this year the new automotive laboratory of the Sun Oil Company at Marcus Hook, Pa., was thrown open for inspection by a group of editors of oil and allied trade journals. The company's chief automotive research engineer, A. Ludlow Clayden, discussed the principal features of the new laboratory and told something of the Sun Oil Company's automotive research program.

The word "automotive" is an expression coined by Howard E. Coffin to characterize any and all air, land, or water vehicles that carry their own power plants along with them in the form of a gasoline or a Diesel engine. This takes in all cars, trucks, tractors, airplanes, motor boats, armored tanks, and in general, all power plants, whether ambulatory or stationary, that generate power by means of an internal combustion engine. The reason why a large oil company should have an automotive research laboratory is that the demands put upon automotive engines are exceedingly diverse, not only as regards the kind of fuel burned, but also as regards the kind of lubricants needed by the engines and their moving parts. Not only is it necessary to have fuel and lubricants adapted to a particular type of engine working under normal conditions, but also for operation under abnormal conditions such as extreme variations in temperature and altitude must be considered.

An oil company's automotive research laboratory has not only to evaluate the quality and performance of the company's products in existing engines, but it has to be in a position to advise the builders of automotive engines as to what new engines might be built to utilize new fuels and lubricants. In other words, the oil manufacturers and the engine builders have to regard themselves as a team which is called upon to work out a combination of fuel-engine-and-oil that will develop the joint effect of fuel and engine in the most efficient manner. This perception of the general automotive problem as a dual problem which must be solved as a whole is of comparatively recent date. Formerly the automobile manufacturers were somewhat disposed to design the engines first and call upon the oil men to provide a fuel and lubricants suited to that engine, with results that were not always satisfactory to either side or the consumer. On the other hand, the oil men were disposed to overemphasize the special qualities of their products, as in the "octane race" of several years ago, when fuels of quality better than needed by most existing engines were produced and extensively advertised.

Under the new system of team-work the engine designers first ask the oil manufacturers what they have; the oil manufacturers advise the engine designers of the invention or discovery of new oil products, and suggest that engines be designed to utilize the improved qualities.

The automotive section of the Sun Oil Company's development division, therefore, has three main functions. Primarily, it supplies a proving ground for testing, in actual engines, either in the laboratory, or in services on land or sea, or in the air, of new ideas in fuels or lubricants originated by other development research sections of the company or suggested from the outside.

Secondarily, it is the duty of an automotive research group to keep in close touch with what is going on in the way of engineering development in the manifold branches of automotive activity, in both engines and oil. The object is to try to anticipate the demand which will come a year or two hence for new fuels or new lubricants to take care of new engines or other mechanisms, so that the company will be apprised of likely demands for new products and make advance preparations for meeting these new demands.

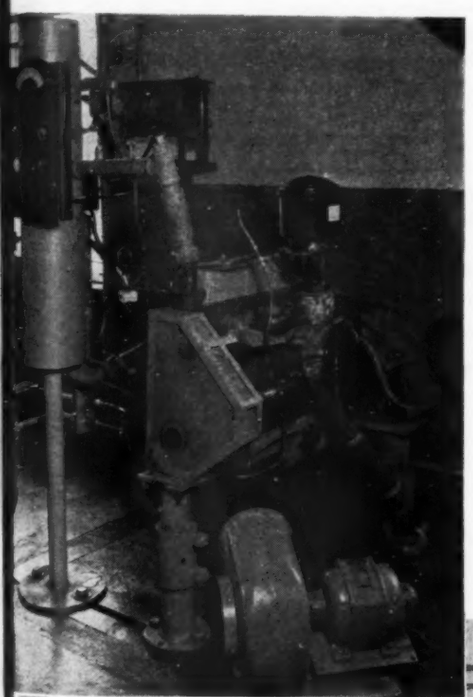
Thirdly, there is the everlasting work in which both the petroleum industry and the automotive industry cooperate; this is the teamwork the object of which is the invention, the development, and the perfection of mechanical meth-

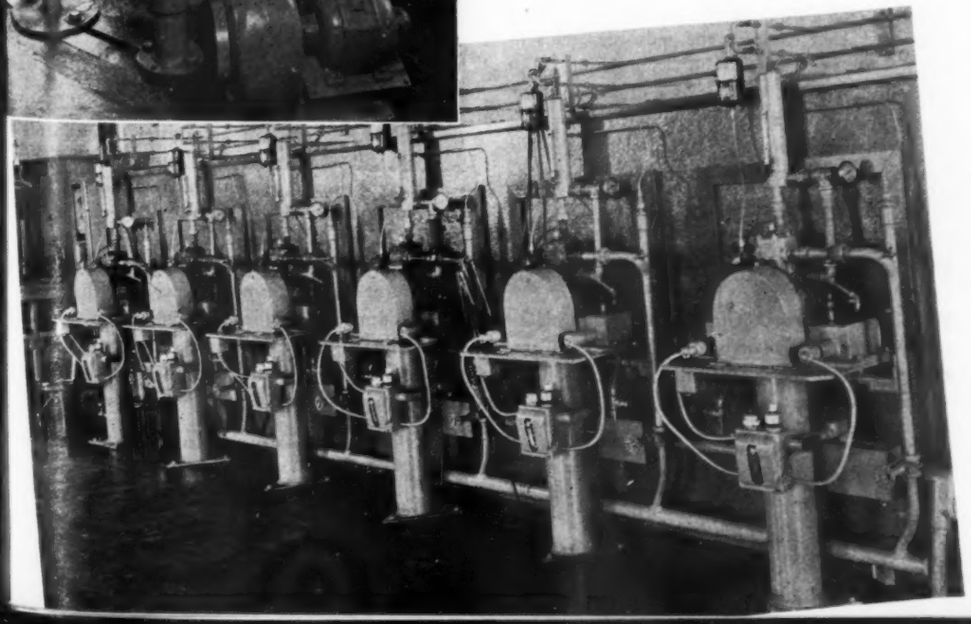
ods of testing both machines and oil products with the objective of furnishing the ultimate user with the best possible combinations thereof. This kind of cooperation has been most intensive in the cooperative work which resulted in the methods of testing aviation gasoline and gasoline engines; without such cooperation the United States would be years behind its present preeminence in civil and military aviation. Without this, its motor car engines and motor gasolines would have been ten years behind what they are today.

For such purposes has the Sun Oil Company established its new automotive laboratory. This is not to say that the company has not heretofore carried on automotive research, but in the past the work has been done in different departments and divisions, each more or less preoccupied with its own more or less circumscribed problems. Now all this work has been brought together under one roof and under a single direction, with a staff of workers who become imbued with esprit de corps and whose efforts are coordinated and integrated with greater effect than was possible when separated.

The new Sun laboratory is not the first automotive research laboratory to be set up by an oil refining company, nor is it as yet one of the largest. The Standard Oil Company of New Jersey has lately put its $500,000 automotive laboratory in commission; the Continental Oil Company and some others already have similar institutions, and there are reports of others on the way. The new Sun laboratory might be regarded as one more symptom of a general trend among the major oil companies to avail themselves to the full of new resources of science and materials, in order that they may be prepared to meet the opportunities and responsibilities of the new era in automotive power that is certain to come in the post-war period.

It is also a fact that the Sun automotive research laboratory, and presumably the similar laboratories of other companies, is not yet going all out on post war automotive problems. The exigencies of the war are still monopolizing practically all the time, genius, and energy of petroleum researchers. For a full three years Sun's automotive research has been concentrated almost wholly upon aviation fuel and upon motor oils and other lubricants for military vehicles. And as between these two—fuels and lubricants—it is the lubricants that are absorbing the most attention; two thirds of the total time and labor go to the lubricants and one third to the fuels. Gasoline may drive an armored tank, but the tank cannot stand the stress of combat unless it is properly lubricated. Lubricating a tank engine, which is often running at all-out full power under the most arduous conditions, calls for lubricant qualities which at this time appear entirely unnecessary for peace time service. Since the war began much has been accomplished with both fuels and lubricants, but it is not permitted to say anything about these accomplishments except that more has been done since Pearl Harbor than would otherwise have been done in perhaps twenty years of peace. What the present day automotive researcher hopes is that the day is not too far off when he will be able to get to work on testing post-war motor gasoline, motor oils and other lubricants in the laboratory and on the road; likewise post-war aviation fuels and aviation engine oils, diesel fuels and oils for trucks and busses, into which he will help the manufacturing department put as much of the qualities developed in meeting war needs as can be adapted to peace time purposes.





Left: Installation for Routine Motor Oil Testing.

An automotive laboratory is essentially a number of rooms full of internal combustion engines—big engines, little engines, medium sized engines. These engines comprise all the usual types and are varied in design and construction so as to subject fuels and lubricants of different natures to a wide range of operating conditions. Everyone of these test engines has to have means for absorbing its output of power, so that speed, power, temperature, and all kinds of other circumstances can be controlled, and so that almost any kind of engine can be run under conditions that closely imitate those that the engine will meet when put to the practical work for which it was designed. In such a laboratory the test engines are always changing. As soon as one engine has been run through one planned cycle of tests it is dismounted and replaced by another engine to run through another testing program.

It is claimed for the Sun automotive laboratory that, while it is not the most elaborate or the most costly, it is about the most efficient of any belonging to anyone either in the oil industry or other allied industry, and that it can turn out good work faster than any other one known to its director. The claim is founded on auxiliary services that combine simplicity and flexibility with complete adequacy; fuel is piped from main storage tanks so that it can be led to whatever engines are in use at the moment, and then swiftly adapted to a different engine when that becomes more interesting. Each engine stall is provided with electric circuits for operating automatic controls for varying speed and load, and other circuits for registering speed, pressure and temperature. The engine batteries can be charged from a central charging station without the necessity of removing them, which saves much time. A system is provided for removing the exhaust from many engines. A vacuum system evacuates fumes from engine crank cases, exhaust and vacuum lines lead to the bottom of a single steel stack and cold water is fed into the exhaust connection of every engine. This permits the connection between the engine and the first line to be made with rubber hose which has great advantage over solid couplings. All of which, and more, adds up to flexibility and quick change which permits fast but unhurried testing work.

For power absorption, three systems are in use. One, a direct current system for cradle type dynamometers; the second, A. C. dynamometers which require only a small supply of D. C. exciting current; and the third, which is employed rather generally, is the use of absorption fans for making runs under standard conditions, as for example the standard Chevrolet test for HD oils. A fan is much simpler than an electrical unit and when once it has been carefully cali-

(Continued on page 110)

Left: Small Single Cylinder Lauson Engines for Preliminary Oil Tests.

ECHOES FROM THE WASHINGTON OIL FRONT

By W. J. Maddox, *Chief of World Petroleum's Washington Bureau*

O'Mahoney Committee Head

SELECTION of Joseph C. O'Mahoney of Wyoming as chairman of the Senate Oil Policy Committee to fill the vacancy caused by the death of Senator Maloney of Connecticut brings to the job a man who has had extended experience in petroleum investigations. At the time the committee was first getting under way O'Mahoney was considered a likely selection for the chairmanship, next to Tom Connally of Texas. But the big Texan thought he had enough to do heading the Senate Foreign Relations Committee and O'Mahoney let it be known among his colleagues that he would rather not have the job.

Joseph C. O'Mahoney

The Wyoming Senator is a member of the Public Lands Committee and was chairman of its subcommittee which conducted extensive hearings several years ago on the development of mineral resources. O'Mahoney also put through the Senate a bill for extending the Bureau of Mines' research into synthetic liquid fuels.

Overton Joins Committee

APPOINTMENT of Senator Overton of Louisiana to fill the vacancy caused by the death of Senator Maloney of Connecticut rounds out the membership of the Senate Oil policy committee. Overton was appointed from the Commerce Committee, which, according to the distribution of membership, is entitled to two representatives on the oil policy group. While not an oil man himself, the Louisiana Senator's state holds a leading place in production. The policy committee is marking time in its consideration of a foreign and domestic oil policy for the United States, waiting for the Senate Foreign Relations Committee to take up the Anglo-American oil pact. In executive session, however, members have given considerable attention to the proposed Saudi-Arabian pipe line.

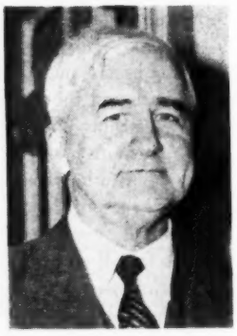
Oil Agreement Rerevise

THE Anglo-American oil pact, as rewritten by the State Department following the revision proposed by the policy committee of PIWC, appears to be headed for re-presentation to the Senate shortly after the March meeting of the War Council. Charles Rayner, State Department petroleum advisor, has been scrutinizing the redraft of the agreement to see that it carries out the suggestions of the Council's oil policy committee and at the same time preserves the essential features necessary for a post-war international understanding on petroleum.

Some rumors have circulated in Washington that the State Department was dissatisfied with the wholly "advisory" capacity industry assigned to the international commission to be set up under the agreement, and that the Department would seek wider powers for the group. There appears to be no foundation for this at all; nor to reports that anti-trust provisions of the pact would be dropped to keep from running afoul of the Department of Justice. The State Department's redraft probably will be unveiled at the March PIWC meeting by Deputy Petroleum Administrator Ralph Davies, who will seek industry approval.

Synthetic Rubber Costs

WHILE still Secretary of Commerce, Jesse Jones revealed that of the million long tons of synthetic rubber produced by Rubber Reserve plants, 737,000 tons were manufactured in 1944. In addition private industry turned out 26,000 long tons last year. According to Jones, the country's synthetic rubber plants are capable of producing 1,000,000 long tons annually, if necessary. In some of the government plants synthetic rubber is being produced at 18 to 20 cents a pound or less, about the prewar cost of the natural variety. Jones says that some in the industry feel synthetic can be produced in competition with natural. Government plant cost for 1944, exclusive of plant amortization, is given as approximately 33 cents a pound, which Jones says is due to more than 60 percent of the rubber being made from high-cost alcohol instead of petroleum.



Jesse Jones

Post War Transportation

POST-WAR costs of transporting petroleum and products, the Interstate Commerce Commission says in its revised edition of Post-War Traffic Levels, are likely to remain in the same relative grooves as before the war, namely lowest by tank ship, followed by barge, pipe line, tank car and motor truck. The Commission points out that "with the return of a full fleet of tank ships to domestic service there will be an excess of transportation facilities for the movement of oil, and that the carrier, or combination of carriers, which can deliver oil at the least cost will probably get the traffic.

"Some of the many pipe lines which have been constructed since 1940 will be continued and others will be abandoned after the emergency. The ultimate disposition of certain lines can be foretold with greater certainty than can that of other lines."

As for the two 'big" lines, the Commission assumes, "as a basis" for estimate, that the Big Inch line will be used for transportation of petroleum products after the end of the war period and that the use of the Little Inch for such purposes is unlikely. The questions of sufficient oil supply fully to utilize these lines are considered and agreement among the major oil companies in the New York-Philadelphia area to use the Big Inch is also assumed."

ICC expects the rails to lose "considerable volume" to the pipe lines, and believes that the Southeastern and Plantation lines will cut deeply into rail and tanker volume in their territory. Although operating costs favor the Big Inch over tankers, the difference is so small that a rise due to less than capacity use would wipe out the advantage.

New Post for Jackson

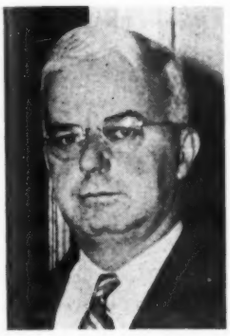
Fred G. Jackson

FRED G. JACKSON, newly promoted to assistant director of PAW'S Foreign Supply and Distribution Division, will continue as Canadian representative of PAW, working closely with the Canadian Oil Controller's Office. He will also administer the scheduling and planning of the distribution of foreign crude.

In announcing Jackson's promotion, Deputy Administrator Davies termed his work with PAW "outstanding" and said: "His efforts have added materially to the excellent relations that exist between the petroleum administrations of this nation and Canada."

Before his appointment to PAW in December, 1943, Jackson, who comes from Houston, was a private petroleum consultant in Texas for seven years. He was graduated from Marietta College in 1918 and started work with the Carter Oil Company in the production department. In 1922 he transferred to the Romano-Americana Company, in Romania, where he served as production foreman and later as district superintendent. He returned to the United States in 1931 and attended the Columbia School of Business Administration, where he received a master's degree. He spent 1933 in Venezuela with the Creole Petroleum Company, later returning to Texas and then joining PAW as a consultant.

Rubber Conference



B. F. Haley

REPRESENTATIVES of the Netherlands, Great Britain and the United States, meeting here as an "informal rubber study group," January 22-27, agreed that actual production of natural rubber areas, if required, could rise in three or four years after liberation of the Far Eastern territories to about 1½ million tons a year. World productive capacity of synthetic rubber would approximate 1-1/3 million tons annually, the delegates estimated. As against this, the group thought the amount of rubber processed and consumed is not likely to reach more than 1½ million tons annually of all types, natural and synthetic. Even the banked-up demand throughout the world for rubber and rubber goods was not expected to hike this figure, as the accumulated demand can only be met gradually. Delegates pointed out that this consumption estimate, however, assumes no sudden and new uses for rubber after the war. B. F. Haley, director, Office of Economic Affairs, State Department, presided over the meeting. The Netherlands delegation was led by P. H. Westermann, head of the Economics Section, Netherlands Ministry for the Colonies, and the United Kingdom delegation by O. S. Franks, Second Secretary, Ministry of Supply. Following the meeting the foreign members of the group left Washington for a tour of synthetic rubber and manufacturing plants.

Oil Price Committees

OPA'S two big advisory committees on crude prices, one composed of representatives of producers and the other from the refining industry, have now been appointed and are ready to swing into action. The twenty-three members of the producers' group, selected by the industry, held its organization meeting in January and is now conducting a cost survey as recommended by the House Small Business Committee. The survey is directed to determining whether existing crude price ceilings are adequate or if an industry-wide price increase is needed. The committee comprises independent producers and representatives of major producing companies.

The refiners' industry advisory committee, composed of eleven major oil refiners and eleven independent refiners, will hold its first meeting with OPA this month to discuss a study to be made of operating costs to determine the question of refiners' ability to absorb any general price increase that may be granted producers. The group includes specialists in the field of refinery production, economics and marketing.

Members of the committee are: W. S. Zehrung, president, Pennzoil Company; W. H. Bennett, vice president, Frontier Fuel Oil Corporation; Paul G. Blazer, chairman, Ashland Oil and Refining Company; Max M. Fisher, vice president, Aurora Gasoline Company; C. L. Henderson, president, Vickers Petroleum Co.; John W. Boatwright, manager, Sales Research Dept., Standard Oil Company (Indiana); B. L. Majewski, vice president, Deep Rock Oil Corporation; Neil Buckley, vice president, Taylor Refining Company; R. L. Tollett, president, Cosden Petroleum Corporation; Stewart P. Coleman, chief, Economics Dept., Standard Oil Company (New Jersey); Horace G. Dale, Mfg. Dept., Shell Oil Company; D. P. Hamilton, president, Root Petroleum Company; Roland V. Rodman, vice president, Bay Petroleum Corporation; C. A. Johnson, chairman, Socal Oil and Refining Company; W. H. Beekhuis, asst. comptroller, Standard Oil Company of California; L. T. Cramer, manager, Sales Administration, Continental Oil Company; Sidney A. Swensrud, vice president, Standard Oil Company of Ohio; C. F. Salzer, asst. to general auditor, Gulf Oil Corporation; William L. Stewart, Jr., executive vice president, Union Oil Company; J. S. Worden, mgr. of refining operations, The Texas Company; M. F. Foster, Phillips Petroleum Company; Harry H. Fuller, mgr. bulk sales, Sinclair Refining Co.

Members of Producers' Advisory Committee

BOTTOM row, left to right: James W. Johnson, Consolidated Gas Co.; Russell B. Brown, general counsel, IPAA, and counsel for the committee; C. E. Reistle, Jr., Humble Oil and Refining Co.; Sumner T. Pike, director, Fuel Price Division, OPA; Charles F. Roeser, Roeser and Pendleton, Inc., chairman of committee; O. D. Judd, associate director, Fuel Price Division, OPA; James V. Brown, petroleum analyst, IPAA, secretary-treasurer of committee; W. Page Keeton, price executive, Petroleum Price Branch OPA; John F. McCormack, head of crude oil production section, OPA; J. P. Coleman, McCarty and Coleman.

Middle Row, left to right: Gilbert J. Mueller, Argo Oil Corporation; A. C. Rubel, Union Oil Company; E. B. Reeser, Barnsdall Oil Corporation; George Bays, Stanolind Oil and Gas Company; E. P. Potter, Amerada Petroleum Corporation; Major B. A. Hardey, Louisiana Minerals Board; W. B. Emery, Ohio Oil Company; Edwin W. Hayes; R. B. Kelly, Pure Oil Company; J. D. Sandefer, Jr.; William L. Clark, Stripper Well Section, OPA.

Top row, left to right: C. P. Watson, Seaboard Oil Corporation; H. M. McClure; John G. Pew, Sun Oil Company; W. H. Morgan, R. R. Bush Oil Company; Dana H. Kelsey, Sinclair Oil Corporation; Howard J. Whitehill, Whitehill Oil Corporation; J. P. Jones; N. W. Shiarella, Miller and Shiarella; Merle Becker; W. C. McBride, Inc.

Oil Company Staff Changes

David Proctor

DAVID PROCTOR, secretary and assistant general counsel of the Gulf Oil Corporation has been appointed a member of the American Petroleum Industries Committee. Mr. Proctor was born in Cuero, Texas. He graduated from the University of Texas, with a law degree in 1915 and after service in World War I, began the practice of law at Victoria, Texas. Shortly thereafter he joined the legal staff of the Gulf in Fort Worth. In 1937 he was transferred to Pittsburgh, and was elected secretary of the company. On January 1, 1943, he was appointed assistant general counsel of the corporation.

JOHN R. SUMAN, of Houston, Texas, has been elected a vice president and director of Standard Oil Company (New Jersey). Wallace E. Pratt, who like Mr. Suman came to Jersey Standard from Humble Oil & Refining Company, has resigned as vice president but will continue as a director and member of the executive committee of the company.

Mr. Suman is one of the most widely known men in the American oil industry. He became a director of the Humble organization in 1927 and was made vice president in charge of production in 1933. He is a director and former president of the American Institute of Mining and Metallurgical Engineers, from which he received the Lucas medal in 1943, and is a member of many other scientific societies and author of many technical papers. His book "Petroleum Production Methods" has long been a standard reference work. A native of Indiana, he is 54 years old.

Mr. Pratt, one of the country's most widely known petroleum geologists and executives, has been identified with the finding and development of oil resources in many parts of the world. He is author of "Oil in the Earth" and of many other important contributions to petroleum literature.

ARTHUR E. HECKER, formerly vice president and general manager of Chemical Construction Corporation, has been elected president to succeed the late W. S. Stowell. Mr. Hecker was a Captain in the Ordnance Department of the U. S. Army during World War I and subsequently one of the principal engineers of Nitrogen Engineering Corporation whose synthetic nitrogen fixation processes were transferred to Chemical Construction Corporation in 1934. For several years prior to the present war, he was in charge of the European engineering offices of these companies.

Blakeslee Barnes, vice president of Chemical Construction Corporation, has assumed the additional duties of general manager. R. E. Lapean and S. F. Spangler have been elected vice presidents.

John R. Suman

Arthur E. Hecker

Herbert R. Macmillan

HERBERT R. MACMILLAN, vice-president and general counsel of the Macmillan Petroleum Corporation, and a former president of the California Oil and Gas Association died at his home in Los Angeles on January 13.

Born in Unionville, Nevada in July, 1876, Mr. Macmillan received his early education in the public schools of Nevada, California and Utah and graduated in law from the University of Michigan. He practiced law in Utah and was president of the state bar association for three years before his removal to California.

PHILIP G. WHARTON, general auditor of The Atlantic Refining Company since 1935, has been elected a vice president of the company. Mr. Wharton has been with Atlantic since 1911, serving for most of that period in the auditing department. He is a past president of the National Office Management Association, a director of the American Management Association and a member of the panel of arbitrators of the American Arbitration Association.

J. P. Miller Jr., was named general auditor to succeed Mr. Wharton.

Philip G. Wharton

Parental pride

Processes are the offspring of our research. Research is our business. We are part of these processes—they are part of us. We know what they should produce. Our aim is to see that they do produce.

CATALYTIC CRACKING	*THERMAL CRACKING*	*RETREATING*
CATALYTIC REFORMING	*THERMAL REFORMING*	*POLYTREATING*
HYDROGENATION	*HYDROFORMING*	*U. O. P. CATALYSTS*
ALKYLATION	*DEHYDROGENATION*	*UNISOL TREATING*
ISOMERIZATION	*POLYMERIZATION*	*U. O. P. INHIBITORS*

Universal Oil Products Co.
Chicago 4, Ill., U. S. A.

UOP

Petroleum Process Pioneers
For All Refiners

The Refiners Institute of Petroleum Technology

William H. Farrand

WILLIAM H. FARRAND, formerly production superintendent for the Pacific Coast division of The Texas Company, has been made a vice president and director of American Overseas Petroleum Company with headquarters in San Francisco. Mr. Farrand has been identified with production activities in California for the past fourteen years and prior to that time he saw service with Romano-Americana in Romania. American Overseas is a jointly owned subsidiary of The Texas Company and Standard Oil Company of California in charge of properties outside the United States except those in Saudi Arabia and Bahrein.

FRANK A. WATTS who has served as purchasing agent for Humble Oil & Refining Co. for the past several years has been appointed sales manager. During 1943 and the early part of 1944 he was on leave while serving as director of the materials division of PAW in Washington. His connection with Humble extends back over twenty-five years during which period he has held a number of posts including that of chief engineer of the sales department. Mr. Watts is succeeded as purchasing agent by F. T. Fendley who has been assistant buyer for more than ten years.

JUDSON LAIRD has been appointed assistant to Franklyn Waltman, Director of Public Relations of Sun Oil Company, and will be in charge of public relations at the company's Marcus Hook, (Pa.) and Toledo, (Ohio) refineries. Mr. Laird has been editor of Sun News, a Sun Oil Company house publication, since 1938.

William J. Getty, Jr., formerly associate editor of Sun News, succeeds Mr. Laird as editor of that publication. Mr. Getty has been at the Marcus Hook refinery since December, 1926, and has been on the staff of Sun News since November, 1942.

George O. Suman

GEORGE O. SUMAN, superintendent of production and development for Tide Water Associated Oil Co. San Joaquin Valley District, Bakersfield, Calif., has been appointed national chairman of the Pacific Coast District of the American Petroleum Institute's Division of Production. Mr. Suman succeeds the late W. L. Jarvis of The Texas Co.

Mr. Suman has had a long experience in the producing branch of the petroleum industry. He entered the employ of the Tide Water Associated Oil Co. in 1920 as assistant resident geologist for the Kern River District, becoming resident geologist the following year. Since 1936 he has been superintendent of production and development for all fields in the San Joaquin Valley.

CAPTAIN CHARLES V. KOLT has been appointed Petroleum Attache to U. S. Embassy at Bogota succeeding Roy W. Merritt who resigned several months ago. Capt. Kolt was formerly attached to the Petroleum Division, State Department, Washington, as Asst. to the Chief of Materials & Production Section. He also has served as Asst. Chief of Purchase Section of the Fuels & Lubricants Division, Office of the Quartermaster General, U. S. Army and at an earlier date was connected with Mene Grande in Venezuela in the transportation department.

NORTHROP CLAREY, assistant to the president of Standard Oil Company (New Jersey) for the past nine years, has resigned that post but will continue with the company on special duties. Mr. Clarey has been with Jersey Standard for more than twenty-five years and is widely known through his close identification with the public activities of the company. Prior to joining it he was connected with the National City Company and the Wall Street Journal and was at one time financial news editor of The New York Times.

John D. Collins

JOHN D. COLLINS, director in charge of District No. 1 of the Petroleum Administration for War and a vice-president of Tide Water Associated Oil Company, died on Saturday, January 20, 1945, following a heart attack. He was 52 years old.

Mr. Collins had been connected with Tide Water Associated Oil Company for nearly 24 years, starting as a clerk in the accounting department. In 1925 he became sales supervisor of accounting and was successively promoted to assistant to the general sales manager, assistant sales manager, assistant general sales manager and general sales manager. In 1936 he was appointed a vice-president. Since June 5, 1944, he had been on leave of absence acting as director in charge of District No. 1 of the Petroleum Administration for War, with headquarters in New York City. He had previously served as a member of the District No. 1 subcommittee of supplies and distribution of the Petroleum Industry Committee.

Charles L. Harding of the legal department of Socony-Vacuum Oil Co. has been named acting director to succeed Mr. Collins. Mr. Harding previously had served in this position and accepted the appointment on the understanding that his tenure of office would be temporary only.

PARKER L. MELVIN, Pennsylvania oil executive who has been an active participant in the industry's association affairs, passed away on January 24 at the age of 51. A former president of the Pennsylvania Grade Crude Oil Association and the representative of the state on the Interstate Oil Compact Commission, Mr. Melvin has been a member of the Petroleum Industry War Council since its organization in 1941. He was a director of the American Petroleum Institute and a director and member of the executive committee of the Independent Petroleum Association of America.

(Continued on page 102)

WHEN YOU NEED Lap-Joint Stub Ends

Whenever a flanged joint is required, the lap-joint stub end has a great advantage over flanges welded to the pipe. The swivel flange makes it unnecessary to accurately line up the bolt holes before welding; "setting up" is simple and quick because no special clamps or jigs are required to hold the face of the flange absolutely perpendicular to the axis of the pipe. The result is a real saving in time and cost of welding. Field crews report a saving of 25% in erection time for making up a joint using Midwest Lap-Joint Stub Ends in comparison with flanges rigidly fixed to the pipe.

Specify MIDWEST FOR THESE REASONS

FORGED LAP—by special Midwest process that simultaneously upsets pipe and forms lap. Tests prove superiority of process.
LARGE RADIUS FILLET—More metal, hence greater strength, in the critical area of lap where maximum total bending and shearing stresses occur.
HEAVY LAP—After machining front and back, lap is always at least equal to pipe wall thickness.
STRESS RELIEVED—Metal in lap is worked at forging heat, then normalized to assure uniform, close grained structure. Photomicrographs frequently show it to be superior to original pipe metal.
SQUARE CORNER—(instead of a round corner) adds to lap strength and eliminates pockets for accumulation of condensate and sediment which promote corrosion.
MACHINE BEVELED—welding end is accurately machined for easy welding.
PHONOGRAPHIC FINISH—of lap face to hold gasket more securely.
UNIFORM FLANGE BEARING—Back face of lap carefully machined to assure uniform flange bearing necessary to satisfactory joint.
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WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing with Technical and Economic Aspects of the Petroleum Industry—Edited by Dr. O. W. Willcox.

OPERATION

Wells Successfully Reconditioned with Explosive-propelled Marbles—J. Gordon Burch, in Oil Weekly, vol. 114 (1944) No. 11, pp. 31-33.

A new tool, called the Burch agate torpedo, has been introduced for cleaning congested porosity on the face of pay sections and for similar purposes. It consists of two concentric tubes; the inner tube, which is 1-1/2 inches in diameter, is made of tin and is filled with an explosive. The outer tube is 3 inches in diameter and may be made of paper or tin, depending on the conditions of submergence. The annular space between the two tubes is filled with 5/8 inch clear crystal, heat-treated glass marbles, which are spaced so that there are 10 marbles in a ring and 22 rings per linear foot along the torpedo. The torpedo is designed to be run into the well to cover the portion of the hole that is to be treated with one shot. For convenience the torpedo is made in 5-ft. sections, but may be longer or shorter.

The principle of this torpedo is that it uses the force of the explosive to drive the marbles against the wall of the well at a speed equal to the speed of detonation of the explosive itself. The explosive will drive any kind of material, but for the purpose in mind glass marbles have been found more effective than any other material because when they strike the wall they disintegrate with blasting effect. The marbles reach the wall of the well with such high velocity that they penetrate into the formation to various depths, depending on the nature of the formation and the size of the marbles. The average depth of penetration of a 5/8 inch marble is one inch in hard lime. Metal marbles would penetrate the same depth, but glass marbles have the advantage that they disintegrate after penetrating the formation with blasting effect upon its face. The presence of oil or water has no material influence on the velocity of the marbles which are said to reach and clean the surface more effectively than any other tool or method.

Besides cleaning congested porosity on the surface of pay sections, the Burch torpedo has been used to destroy liners, to ream and under-ream, to clean water, flood, and repressure wells, to knock down shattered formation on the irregularities of shot holes, and to reopen desired parts of formation squeeze-jobs. It has been used safely on all such jobs, open and untamped, and within inches of both cemented and uncemented liners and casing shoes. More than 100 wells have so far been treated for congested porosity at the pay section with this tool. Average increased production effected in these wells has been in excess of 360 percent.

Most of these wells are in the Texas Panhandle with an average depth of 3,100 feet and pay sections 30 to 100 feet; average length of torpedoes 55 feet.

•

Application of Nickel Alloys in Oil Production—B. B. Morton, before National Association of Corrosion Engineers, Houston, April 1944.

After enumerating the use of nickel-containing corrosion-resisting alloys in oil refineries, the author points to their uses in the production division, where drilling for oil and subsequently raising it to the surface presents many problems of corrosion and metal failure.

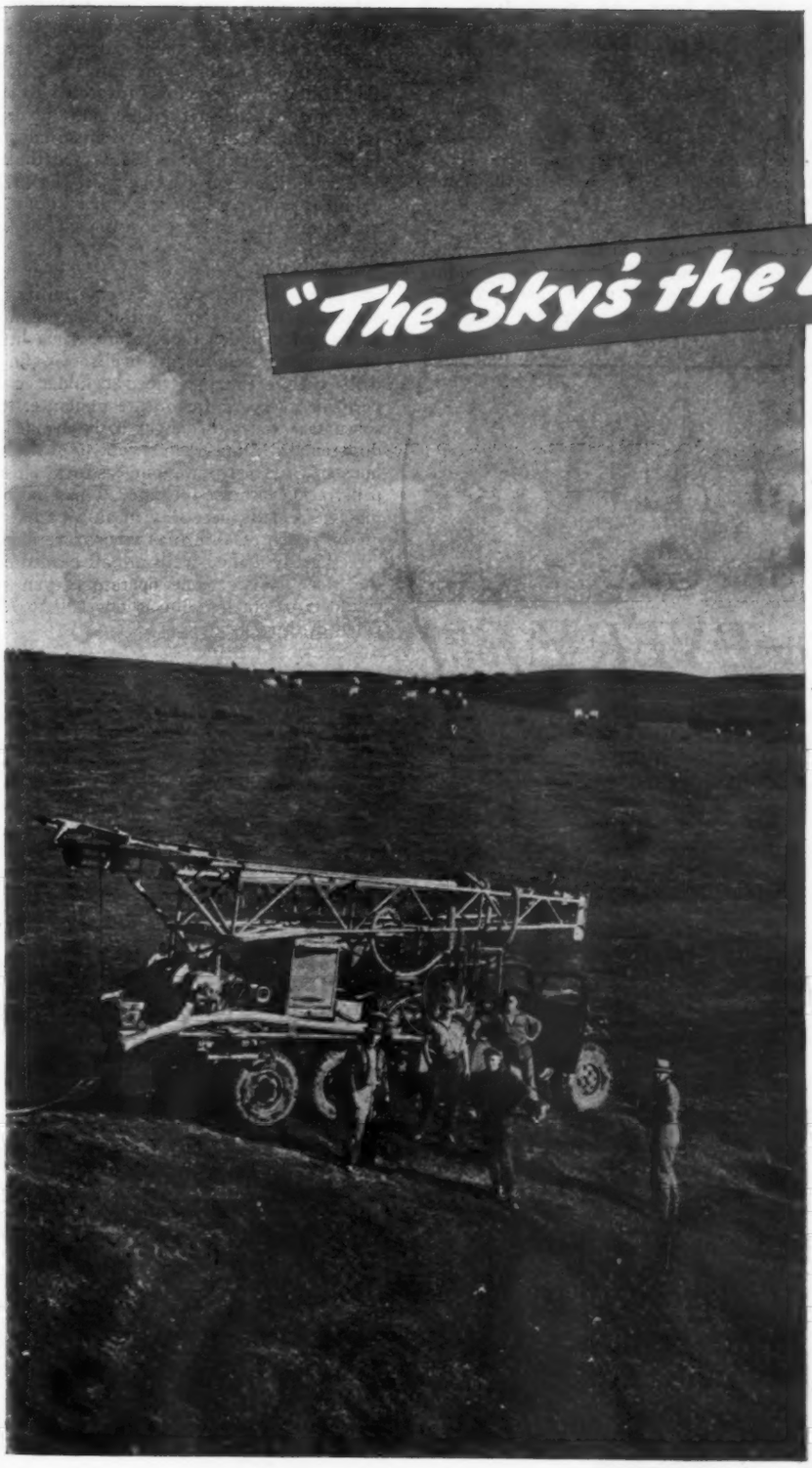
Corrosion fatigue of drill pipe has been noted in many quarters. An effort to offset this difficulty was put forth, prior to the war, by a prominent western oil company by using an alloyed drill pipe. A composition of alloy by the trade name Yoloy was employed. This alloy steel contained approximately 2 percent nickel, 1 percent copper. Its mechanical properties exceeded those specified for Grade D drill pipe. The performance of the Yoloy pipe was reported as excellent and apparently more than justified expectations from a standpoint of resisting corrosion fatigue, abrasion, and the complicated forces acting upon a drill pipe.

Abrasion is always a problem associated with production. Nickel containing alloys, such as the colomonoy group with nickel bases, and the well known lining materials containing nickel and boron find application in connecting with mud handling.

The various types of monel are used in connection with pumping. Monel polished rods have been established a good reputation in West Texas and West Kansas. K-monel balls or drops and seats are excellent for shallow corrosive wells.

A string of K-monel sucker rods in service in West Texas, after about 3 year's service, an

(*Continued on page* 96)



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(*Continued from page 92*)

in excellent condition. SAE 4620 rods gave a life of 6-8 months in the same well. The continued corrosiveness of the well is attested by vigorous attack upon steel parts of the pump. These parts are being replaced by monel.

Monel has long been the material used in gas lift equipment. The bodies are often of regular monel and the valve of K-monel (a hardenable form of Monel).

Ni-resist cast-iron has demonstrated a high order of resistance to the salt water associated with petroleum production. It has long been used in pumps handling brine and contaminated salt water. The use involves liners, pistons, impellers, and valve parts. Monel shafts, rods, and valve parts are used as a result of the well established resistance of monel to salt waters.

Use of Cylinders in Directional Drilling—L. P. Stockman, in Oil & Gas Journal, vol. 43 (1944) No. 19, pp. 77-78, 111.

The so-called cylinder method of directional drilling consists of imagining a cylinder extending from the surface location to the predetermined bottom of the hole; the outline of the imaginary cylinder, which may have any reasonable radius (usually 100 feet) is plotted from the surface to the drilling point before drilling is started. The cylinder outlines the limits within which the driller or contractor is expected to keep the hole; that is, the drift, direction, and degree of inclination are to be kept within predetermined bounds. When the hole is surveyed the reading is placed at the proper point in the preplotted cylinder, and it is noted whether or not the required direction is being maintained.

Among the advantages of this "cylinder method" are listed the following: By controlling the directionally drilled hole within the radius of a prescribed cylinder the operator runs little risk of damaging neighboring wells. Confining the drill within the prescribed cylinder creates a permanent record for future guidance, showing subsurface zones of danger to be avoided. Such directional drilling permits control of the bottom-hole spacing program, and assures satisfactory penetration into the oil sand. This kind of drilling is especially necessary in an area like Huntington Beach (California) where several hundred directionally drilled wells are all headed out into the tide lands. Some operators even prepare cylinders of smaller dimensions (50 to 75 feet) when drilling straight holes.

In the California fields it is found that usually two or three whipstocks are sufficient to keep the holes within the cylinders. Pump speed affects directional drilling to a great extent, and considerable care has to be given to weight on bit, rotary-table speed, and mud. A slow pump speed enables the bit to show increased cutting ability in the direction which has been given to it, though it may increase the deviation unless controlled by other factors. The three factors—pump pressure, rotary-table speed and the weight carried on the bit, when properly coordinated will almost always control the angle of drift and no whipstocks need be employed except in case of necessity. Some drilling contracts prescribe penalties on the contractor for failure to stay within the cylinder.

One operator has drilled and completed about 140 wells by the cylinder method. Not one well was lost because of mechanical trouble, and every well has been bottomed where desired. The average inclination in the Wilmington district tideland wells is about 35°, although some have inclinations as much as 62°. A record deflection of 5,072 feet in a measured depth of 7,027 feet is reported.

CHEMISTRY

Laboratory Fractionation at Atmospheric Pressure of Normally Liquid Hydrocarbons.—H. J. Hepp and D. E. Smith, before American Chemical Society, Division of Petroleum Chemistry, New York, September, 1944.

A generally useful column is described wherein the fractionating section is packed with single-turn wire helices, the column being insulated with an especially designed electrical heater which makes it possible to maintain the fractionating section in an adiabatic condition. This column is equipped with an especially designed head provided with electrical means for automatically maintaining the desired reflux ratio. Columns of this design containing up to about 100 equivalent theoretical trays have been found to operate satisfactorily.

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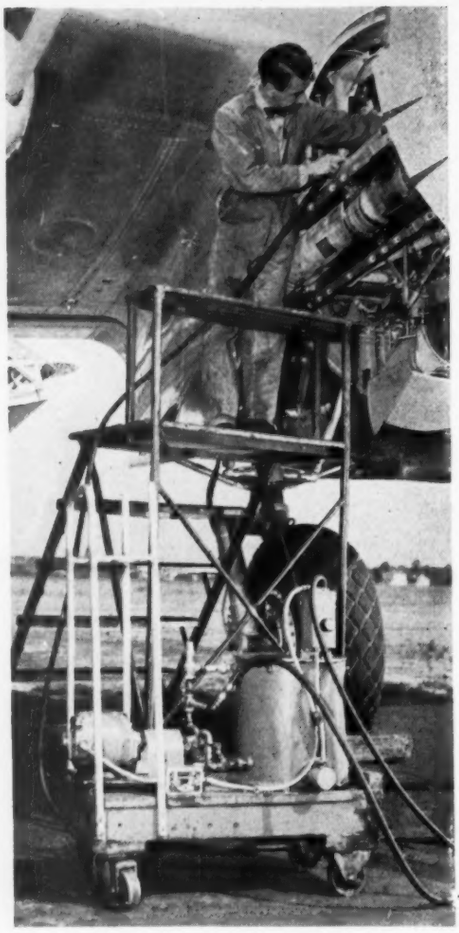


Portable Pre-Oiler for Planes

THE contrivance above portrayed is a portable pre-oiler which delivers pre-heated oil under pressure to the engines of B-26 Marauders thereby assuring complete removal of all preservative compounds and perfect lubrication of all parts prior to their initial runup. It was developed by tool design engineers of The Glenn L. Martin Company, as a result of an Army technical order specifying the use of heated oil in the pre-oiling of engines.

The outstanding feature of the Martin pre-oiler is its compactness. A five gallon oil drum with a thermostatically controlled heating element for heating the oil and maintaining it at a constant specified temperature of 50° to 60°C. and an electric motor driven pump capable of delivering the heated oil at a pressure of from 80° to 100 p.s.i. are mounted on a wheeled truck measuring approximately 15 x 36 inches. A dual purpose frame at one end of the truck serves both as a handle for guiding it and a rack for a 75-foot power cable and a 15-foot flexible oil line.

In use, the power cable is plugged into the nearest electric outlet and the oil line is attached to the oil pressure line at the back of the engine. By limiting the capacity of the oil drum to five gallons, the approximate quantity needed to pre-oil one engine, oil heating time is reduced to a minimum.

In use at the Martin airport for several months, the new pre-oiler has demonstrated its value both as a time-saver and in preventing failures due to improper lubrication of an engine prior to its first start.

New Gas Engine

A DISCOVERY in the Diesel engine field, which will enable the engine operator to use either gas or oil as fuel without any electrical sparking device, and will cut fuel consumption of gas engines by from 20 to 25 percent, is announced by Ralph L. Boyer, chief engineer of The Cooper-Bessemer Corporation, Diesel manufacturers.

Mr. Boyer said that the new discovery is the result of experimentation which began in 1928. Recently efforts have been rewarded by the successful operation of a natural gas engine on the Diesel principle. This enables the unit to operate on a wide variety of fuels including fuel oil, natural gas, manufactured and coke oven gases, sewage gas, and refinery by-products.

The conversion from liquid to gas fuel is as simple as the closing of one valve and the opening of another with the engine operating continuously at full load. Although conversion from one fuel to another has been possible in the past, it has always been necessary to shut down and exchange major or minor parts of the engine. The new principle will enable the engine to have the same fuel economy regardless of the type of fuel used. It raises the normal 25 percent thermo-efficiency of the gas engine to the 35 percent thermo-efficiency common in Diesel oil engines.

Several times since 1928, Mr. Boyer said engineers in the Diesel field thought they had the answer to the multi-fuel conversion problem but in the past it has been thought necessary to inject the gas under high pressure of from 1200 to 1500 pounds. This involved complications which overcame the advantages obtained. The new Cooper-Bessemer development makes possible the use of gas at normal pressure and the change from one fuel to another without the necessity of a shut-down.

The new development is considered to be particularly important to the operation of modern long distance pipe lines. Many of these lines have from 100,000 to 150,000 horsepower of gas engines installed along their length to drive the compressors or pumps. The total fuel used by these engines for 150,000 horsepower would amount to 36,000,000 cubic feet of gas per day, which is about one-third of a single day's total consumption of a city with a population of a million.

When operating as gas engines, it is stated, these new gas Diesels would have from 5,000,000 to 6,000,000 cubic feet of gas for domestic and industrial consumption per day. If the engines are converted to oil fuel the total fuel consumption of 36,000,000 cubic feet of gas could be made available for consumer use.

The Cooper-Bessemer Corporation already has engines embodying the new principle in production along with its standard line of marines and stationary engines and standard compressor units. In addition to the convertibility feature and the possible fuel saving, it is pointed out, the new development in Diesel operation will mean the elimination of one of the greatest fire and explosion hazards in the gasoline refining industry because there will be no necessity for using any ignition or sparking device.

Houdry Changes Royalty Charge

A revised licensing arrangement for Houdry catalytic cracking processes has been announced by Arthur V. Danner, executive vice-president of the Houdry Process Corporation. The plan is applicable to licenses for both the Houdry fixed-bed and the Thermofor Catalytic Cracking processes, and covers catalytic cracking operations generally, regardless of end products. The terms are five cents per barrel of fresh feed charge, with no additional cost for recycling or treating for aviation gasoline production. This is an alternative to the paid-up licensing plan which is still available. "The new plan," Mr. Danner explained, "is designed especially to aid small refiners and assist them in sharing the expanding markets for catalytic motor fuel and specialty products."

Houston To Have a Supply Row

OUTGROWTH of the rapid expansion of Houston as a supply centre for the oil industry is a novel project for a combined industrial and residential development in the eastern part of the city. The site selected for Supply Row as it is to be called is a wooded tract of about 60 acres near Hughes Tool and other large equipment company plants. A portion of the tract bordering Country Club Bayou has been set aside for residential use by officers and employes of equipment concerns which locate in the new development. Industrial sites have access to two railway lines.

The idea of Supply Row was conceived by the Texsteam Company which was the first to locate in the area. Houston Oil Field Material Company is constructing offices and warehouses there and other supply companies are expected to follow suit as building permits become available.

MAKE THIS SIMPLE TEST!

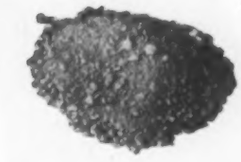
IT SHOWS ONE REASON WHY

AQUAGEL

ELIMINATES MANY MUD TROUBLES BEFORE THEY OCCUR

NATIVE CLAY

NATIVE CLAY



NATIVE CLAY

Obtain small samples of any native clays. Rub the dry material from each sample in turn between the thumb and forefinger. Then do the same thing with a pinch of AQUAGEL. Notice the abrasive grittiness and lumpiness of the native clays. AQUAGEL, on the other hand, feels soft and smooth, and provides a protective coating which resists abrasion.

Now try the same test with the samples moistened with water. The native clays will turn into "mud" slowly and the fingers will continue to detect gritty particles which will abrade the skin if rubbing is continued. AQUAGEL, in contrast, quickly becomes a slippery mud which lubricates and protects.

There are many more reasons why AQUAGEL is the finest mud base for every type of drilling. But the simple test above explains why pump parts and drill pipe show a minimum of wear, why the running of casing is facilitated, and why, in cable tool operations, drilling lines last longer, when AQUAGEL is used.

Patent Licenses unrestricted as to sources of supply of materials, but on royalty bases, will be granted to oil companies and others desiring to practice the subject matter of any and/or all of United States Patents Numbers 1,807,082; 1,991,637; 2,041,086; 2,044,758; 2,064,936; 2,094,316; 2,119,829; 2,214,366; 2,294,877; 2,304,256 and further improvements thereof. Applications for Licenses should be made to the Los Angeles office.

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OIL COMPANY STAFF CHANGES

(*Continued from page 66*)

GEORGE H. METTAM, director and assistant general manager of manufacturing operations of Standard Oil Company of New Jersey, died February 6 in New York City at the age of 55.

During his 36 years' association with the company's refinery operations in New Jersey, Mr. Mettam was also active in civic and philanthropic affairs. He was former vice president of the New Jersey State Chamber of Commerce and chairman of its industrial committee on developments; president for four years of the Bayonne Chamber of Commerce; a former director of the Bayonne Industrial Y.M.C.A.; and former chairman of the advisory committee of Associated Chambers of Commerce.

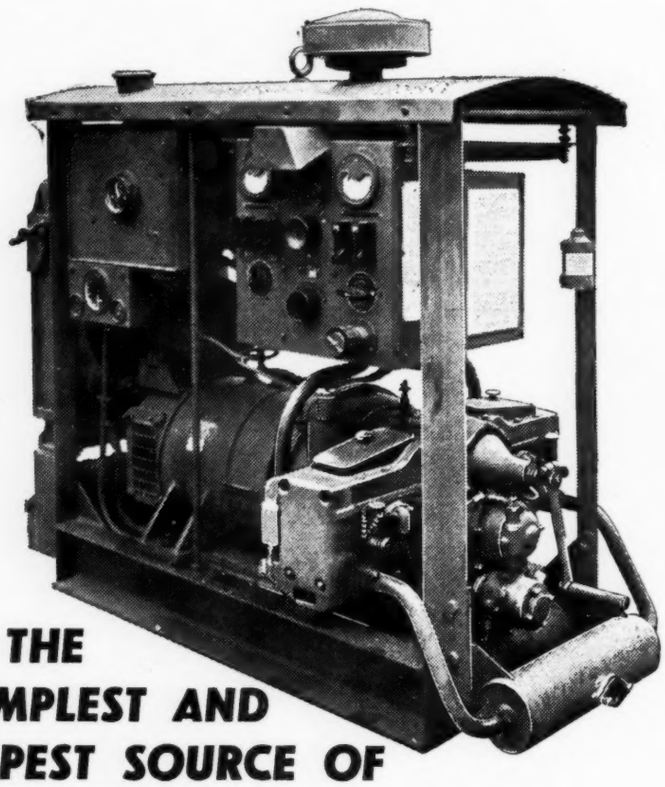
A native of Bayonne, N. J., Mr. Mettam attended schools there and later New York University. He was first employed by the company in the construction of its Bayway refinery in 1907. In 1926, he was appointed mechanical superintendent of the Bayonne refinery, and the following year became superintendent of the mechanical department. He became assistant general manager of manufacturing operations in June, 1940, and was elected a director of the company in March, 1941.

HERBERT L. PRATT, former chairman of Socony-Vacuum Oil Company and a well known figure in the oil industry, died at his home in New York on February 3. Mr. Pratt was a son of Charles Pratt one of the pioneers in the oil business and an associate of John D. Rockefeller in the founding of Standard Oil Company. He entered the service of Standard Oil Company of New York immediately after his graduation from Amherst in 1895, became manager of the company's Pratt works in Long Island City, was elected vice president in 1911 and succeeded H. C. Folger as president in 1923. When Standard of New York was combined with Vacuum Oil Company to form Socony-Vacuum, he became chairman of the board, a position from which he retired in 1935 after forty years service.

LT. COL. WILLIAM B. PLUMMER has been relieved from active duty with the Army Air Forces and returned to service with Standard Oil Company of Indiana. Mr. Plummer was assigned to special work on aviation gasoline in the office of the Under Secretary of War at Washington when he joined the armed forces more than two year ago, but during most of 1944 was with the AAF Eastern Procurement District as Chief of the Contract Termination Section in New York City.

NATHAN J. BEALS, comptroller of the Creole Petroleum Corporation, New York City, and Ralph W. Rager, comptroller of the Oil Well Supply Company, Dallas, Texas, have been elected to membership in the Controllers Institute of America. The Institute is a Technical and professional organization of controllers devoted to improvement of controllership procedures.

OFFICERS of the Houston chapter of Nomads for 1945 are: Tom W. Nelson, Oil Weekly, president; W. A. Davis, Baker Oil Tools, vice president; Charles Thornhill, Thornhill-Craver, secretary-treasurer; Harry E. Estes, Reed Roller Bit Co., assistant secretary-treasurer; E. F. Baldwin, Hughes Tool Co., sergeant-at-arms; Ray Doan, Coffing Hoist Co., assistant sergeant-at-arms; H. J. Craig, Baash-Ross Tool Co., retiring president, and C. E. Whitney, Baker Oil Tools, regents.



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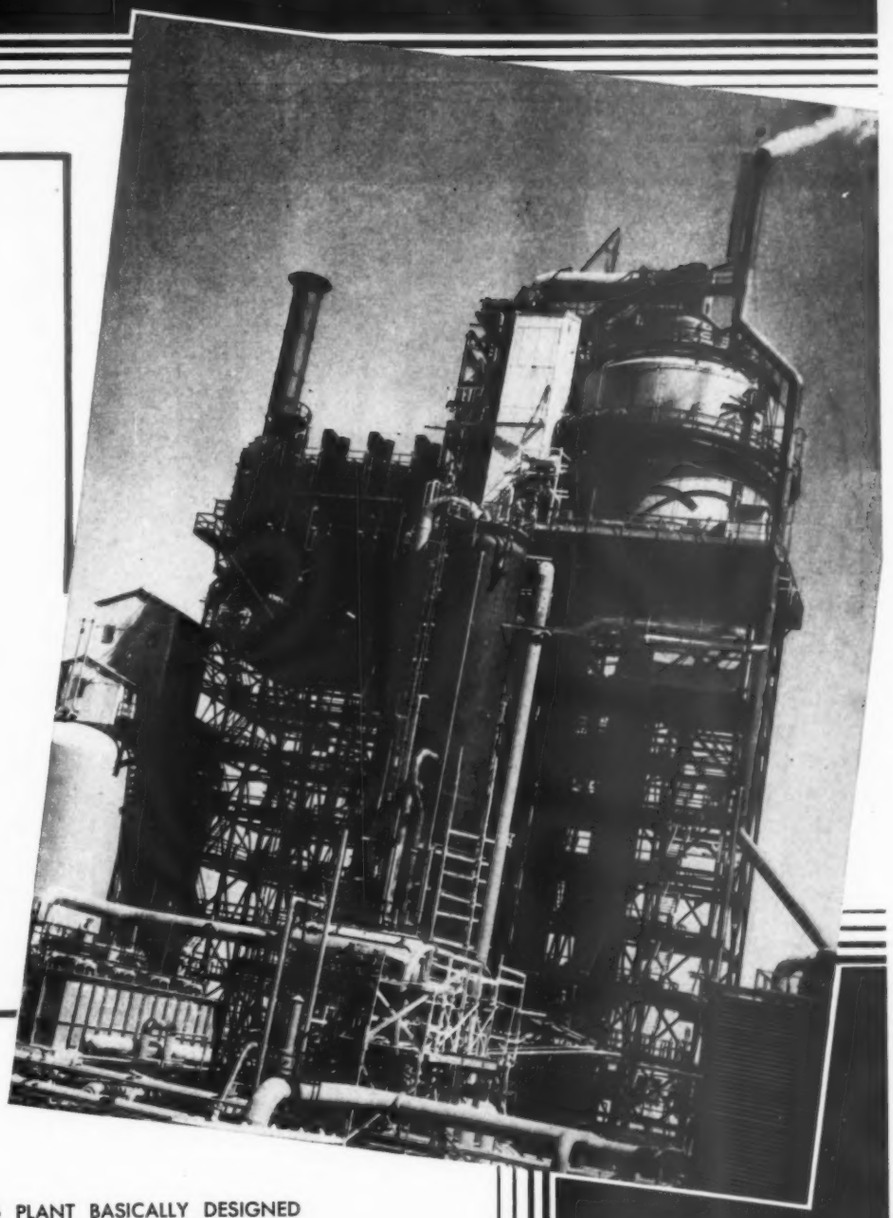

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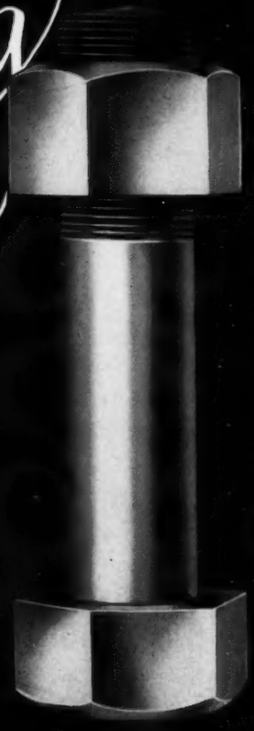

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More Drilling Rigs

(*Continued from page* 45)

each PAW district. Theoretically, such a plan would make drill pipe more readily available to those operators who are unable to plan their needs more than 90 days in advance and to eliminate the necessity for those operators who can plan their needs to order at random their requirements as far in advance as is now required. Such a procedure would necessitate very close cooperation between PAW and WPB to assure the 1945 production of drill pipe at a rate roughly comparable to that of 1944. The need for internal combustion engine parts is so great that normal operations are difficult in many areas. The industry feels that a reasonable supply of parts must be carried by suppliers if frequent shutdowns are to be avoided.

The extreme shortage of housing facilities in at least a dozen large producing areas has made it even more difficult to retain skilled men, especially those with families. Relief was expected for a time from various government housing agencies, but projects have materialized slowly indeed. Additional houses of one type or another must be provided in several districts before additional crews will become available. Already many crewmen are driving excessive distances to and from jobs.

The oilfield transportation system is operating at about 50 percent of its normal efficiency, and the average moving time between wells has increased so much that this loss of time has become one of the chief items in overall cost increase. Trucks are getting old, good mechanics are scarce, tires are limited and poor, and breakdowns are frequent. In one major producing area the moving time between wells increased from 3½ days in 1941 to 12 days at the end of 1944.

The supply of butane has not been enough to meet all requirements, but shutdowns have been surprisingly infrequent from this shortage. A large number of former butane-burning engines have been equipped to burn natural gas, and this conversion has done much to prevent a serious butane shortage among engines not readily convertible. PAW has been most cooperative in its efforts to make the available butane supply do the job. Any operator who can switch from butane to natural gas should do so.

The drilling contractor wants most of all to have the nearest possible approach to continuity of operations. This would permit him to drill most efficiently, through retaining his crewmen from well to well, planning his work in an orderly manner, and generally eliminating the considerable lapse of time formerly recorded between wells. Oil companies appreciate the benefits derived from continuous drilling operations and are cooperating fully with drilling contractors by planning their work well ahead of actual development.

THIS derrickman and Youngstown have both played an important part in drilling the world's deepest well--Standard of California's Kern County K. C. L. 20-13-at 16,246 feet. The drilling string consisted of 180 stands of which the 111 (9900 ft.), next to the bottom ten were Youngstown 3½ in. 15.50 lb. Yoloy. In a hole of this depth the going is tough at any position in the string but especially so near the bottom where drilling stresses and vibrations are at a maximum.

Yoloy, available for both drill pipe and tubing, is a nickel-copper alloy whose superior impact resistance and high endurance limit are well known. Its satisfactory performance in Standard's recently completed world's deepest well in California is one more outstanding proof of the ability of this low-alloy pipe to take it where the going is toughest.

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Sun's Automotive Laboratory

(*Continued from page* 61)

brated it is just as reliable. In the case of the larger units such as Chevrolet engines the engine coupling extends through the outer wall of the building and each fan is in an individual felt lined house. The fan also incorporates a flywheel ring with a conventional starting motor, battery operated, the object of this being to eliminate one of the things which has to be removed and replaced at each engine overhaul. Also on each fan shaft is a simple mechanical overspeed device which can be set to cut the ignition at any pre-desired speed. Safety devices of this sort are used wherever possible on tests where engines run for relatively long periods on a schedule which calls for only occasional attention from the operators.

While this is not always possible, the attempt has been made to provide most of the engine beds with a cooling system and control unit readily adaptable to a fair variety of engines. This unit in the case, for example, of the Chevrolet engines carries the panel board to which all the main services are brought. This means that to change engines it is only necessary to change the connections between the panel unit and the engine itself.

The main test-engine equipment at present consists of single cyclinder engines using fan absorption, Chevrolet engines used mostly for heavy-duty oil testing, and a single cyclinder caterpillar diesel used for the same purpose. There are also a variety of unmentionables, the identity and function of which are shrouded in secrecy. Several pieces to which no great mystery attaches are shown in the accompanying illustrations. These are adapted to cover a wide range of tests on oils, lubricants and motor fuels. The effect of new and old additives and lube improvers on engine performance is a main subject of study with this equipment. The most elaborate and in many respects the most interesting of the restricted equipment in this laboratory is that used for aviation gasoline research. In spite of all the notable improvements that have been made in aviation gasoline since Pearl Harbor, this subject is far from being closed. New ideas on how to improve aviation gasoline are still cropping out from various sources, and many of these ideas are materializing in what Mr. Clayden says are remarkable results.

The war will be over some day; military problems will become less urgent, and there will be time for adapting a great wealth of new knowledge to civilian use. Immediate use of much of the new knowledge for the improvement of automobile and truck transport is not expected. It is figured that 75 percent of the cars that will be on the road when V-Day comes can get along on 76 to 85-octane gasoline for one or more years, and in the meantime the oil men and the engine builders will have oriented themselves toward the new era.

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Oil Property Map of Colombia

Scale: 1 to 1,000,000
Showing in Color

1. Concessions in force of major operators
2. Private oil properties, with firm title
3. Concessions tested and surrendered
4. Location of all wildcats drilled in the country; depths, oilfields; pipelines and stations
5. Concession applications officially accepted

Measures 1.80 x 1.05 meters (6' x 3.5')

E. OSPINA-RACINES
Apartado 27-23
Bogota, Colombia